POWER

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Relativity

IT IS not the wages that one gets in money that counts. It is the purchasing power of one's day's work.

If a workman got ten dollars a day and everything that he had to buy cost twice as much, he would be no better off than as if he got five dollars a day and the price of everything was cut in two.

And inasmuch as everything that he does have to buy is the product of labor, and in paying for it he is indirectly paying off the man who made it, it follows that if labor is high everything else will be proportionately high and the laborer will be no better off than he would be with a moderate wage with its greater purchasing power.

The constant, and natural, effort of labor to increase its wage (in money) works against the laborer in another way. The worker should have a return that will enable him to live not from hand to mouth but comfortably and enjoyably and to put something by for the time when his earning power shall be impaired. If the constant effort and pressure succeed in continually forcing wages upward, the cost of living will go upward too, and the purchasing power of savings will be less when they come to be needed than it was when they were put away.

It is the relative value of the wages of labor by and large to the selling price of its product that means plenty or penury for the workingman.

The struggle of labor collectively should be for a fair proportion of its product, not for extra dollars in the pay envelope, to be handled for a few days and then handed back to the producer and dealer in proportionately higher prices for the things that he must have.

The producer need not care how much he pays for labor if he can pass the increase on to the consumer, which is, in effect, collecting it back from the laborer himself.

The thing for labor to struggle for is for a greater proportion of the selling price of its product, not shorter hours and more dollars per day.

F. R. Low

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Use and Operation of Automatic Hydro-Electric Stations

How the Automatic Station Has Solved the Problem of Developing Small Water Powers—Types of Stations—Operation of a Plant Explained in Detail —Protection Devices—Economies Resulting from The Use of Automatic Stations

By F. R. CULP
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IN the five years that have elapsed since its inception, the automatic hydro-electric station has come to occupy an assured place in the electrical development of the country. Its early development arose from a combination of circumstances under which a need was followed by a means of meeting it. The success of the automatic converter substation led engineers to consider the same or similar methods applied to the development of many small water-power sites that had hitherto been impractical for various reasons. The demand for power was growing, but increasing costs of generation handicapped hydro-electric development. The automatic railway substation had clearly demonstrated the economies of the attendantless station. It remained, then, to apply the same principles to hydro-electric stations, and a forward step in electrical progress would be made.

The first station was tried out in 1917, when a 1,500-kw. three-unit plant was installed in Cedar Rapids, Iowa, by the Iowa Railway and Light Co., and the results of that project were such that a promising future was predicted for the automatic station. The prediction was not rash, as the rapid increase in the use of these equipments has shown. Today they are operating in nearly every state in the country in capacities from 150 to 5,000 kw., and an equipment is being designed for a station with a capacity of over 10,000 kw. Many small water-power sites that were running to waste because of isolation, low head or the expense that would have been incurred in operating them manually, have already been developed, and many more are in the "project" stage.

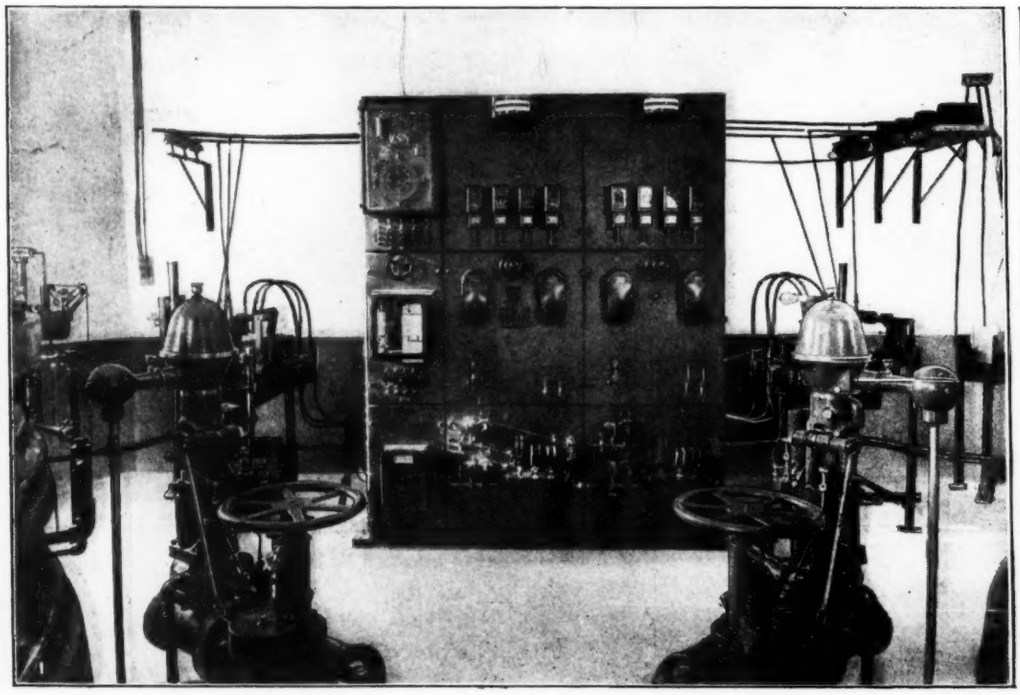

FIG. 1—AUTOMATIC HYDRO-ELECTRIC STATION SWITCHBOARD EQUIPMENT, FAIRBURY MILL AND ELEVATOR COMPANY, FAIRBURY, NEB.

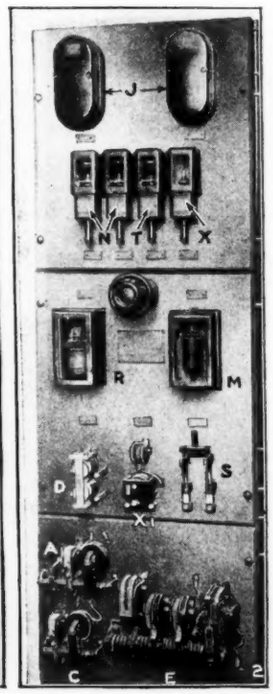

FIG. 2—AUTOMATIC CONTROL PANEL

Fig. 2—*J*, temperature relays; *N*, alternating-current time delay, overload relays; *D*, field relay; *T*, auxiliary to field relay *D*; *X*, exciter over-voltage relay; X_1 auxiliary to exciter over-voltage relay *X*; *E*, exciter relay; *M*, alternating-current over-voltage relay; *S*, control-power switch; *A*, control-current contactor; *C*, master-control contactor; *E*, generator-field contactor.

Solves Operating Problem

The problem that confronted those who wished to develop small, isolated or intermittent sites was one of dollars and cents, with the personal element as a contributory feature. The wages of skilled operators had risen to a point where it was poor economy to maintain the force necessary to keep a manually controlled sta-

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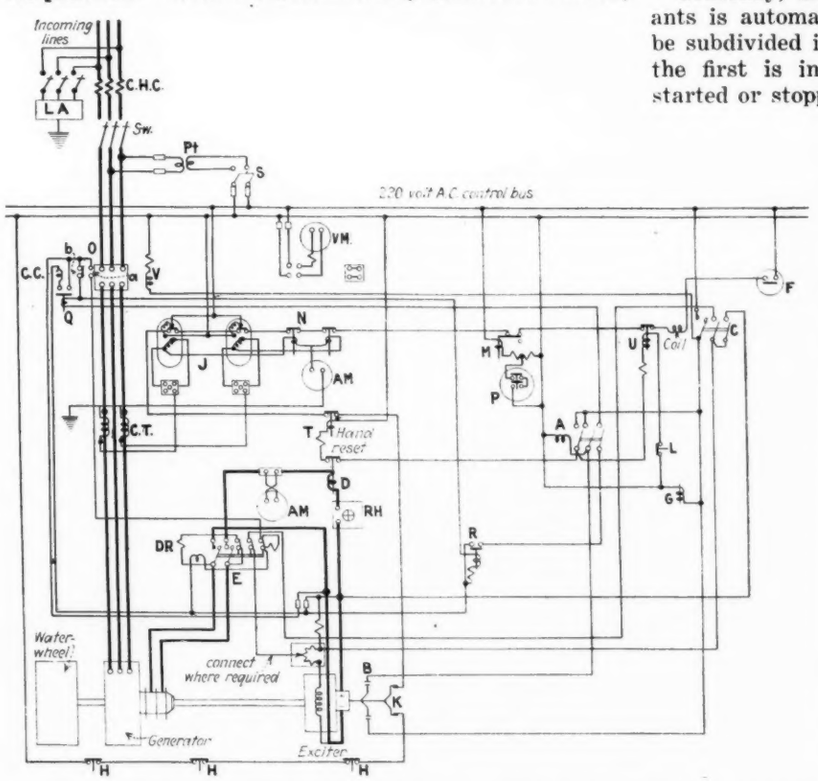
tion of small capacity in operation. The alternative that confronted the power company was that of employing less experienced labor with the consequence of much damage to valuable equipment, if not serious disturbances to the whole system, owing to ignorance or carelessness on the part of unskilled operators.

In some cases the sites were in a country so isolated and lonesome that it would be impossible to keep any sort of operators at the station with assurance that they would be on the job in case of emergencies. Another factor was that the manually controlled station would cost more for buildings and land, etc., than was justified by the return received from it. Even if several small heads should be combined at one manual station, the economic efficiency might be too low to render the project practical. With the automatically controlled station, type of station and its obvious advantages becomes more widespread, other applications will be made.

The equipment of a typical automatic station consists of a waterwheel, direct connected to a synchronous generator, a waterwheel governor, the mechanism for controlling the water gates, and the automatic control equipment. Synchronous generators are generally used. The synchronous machine has proved its reliability, and its control has been perfected and standardized for all sorts of installations. In most cases these generators are provided with an *amortisseur*, or squirrel-cage winding, to assist their pulling into step with as little disturbance to the rest of the system as possible.

Two General Classes

Generally, any station that operates without attendants is automatic, but automatic control systems may be subdivided into two general classes. The control of the first is independent of any other station, being started or stopped as conditions require, by some device



RH	Alternators field rheostat
VM	Voltmeter
V	Undervoltage device
D.R.	Discharge resistance
SW.	Disconnect switch
L A	Lightning arrester
C.T.	Current transformer
C.O.	Current opening
CHC.	Choke coils
C.C.	Closing coil
b	Auxiliary switch, closed when main switch is open.
AM	Ammeter
a	Auxiliary switch, open when main switch is open
L	Limit switch on wheel gate
G	Governor solenoid (furnished with governor)
P	Oil-pressure relay
M	A.C. overvoltage relay
R	Exciter relay
J	Machine temperature relay, time delay overload
E	Generator-field contactor
H	Bearing temperature relay (hand reset)
T	Auxiliary relay for D. Time delay when energized (hand reset)
D	Field relay
N	A.C. overload time delay relay. Hand reset
B	Synchronous speed control switch
K	Over-speed limit switch
Pt	Control-power transformer
S	Control-power switch
Q	Auxiliary relay for O
O	Oil circuit breaker and mechanism
A	Control current contactor
C	Master control contactor
U	Time delay stopping relay, time delay when energizing
F	Master starting element

FIG. 3—WIRING DIAGRAM FOR AUTOMATIC CONTROL FOR HYDRO-ELECTRIC GENERATOR STATION

these evils are remedied by the simple process of elimination. The operator ceases to be a factor in the success of the project. The buildings, too, may be of the simplest type; all that is required of them is to shelter the apparatus itself from the weather.

The function of the automatic hydro-electric station is the supplying of comparatively small amounts of power, which may be delivered into the main system at any convenient point, or to correct the power factor. One case is cited in which, during the time of light load or low water, the generator in the station, instead of being shut down, functions as a synchronous condenser to correct the power factor on the main line. Another field for the small automatic hydro-electric station is supplying power for small factories located in communities not touched by large power systems, which usually are dependent on more or less antiquated mechanical power systems of some sort to turn their machinery. These are only a few of the possible applications that suggest themselves; doubtless as the knowledge of this

such as a float switch, time switch, low-voltage relay, frequency relay, or similar device, actuated automatically. The second depends upon an impulse from a controlling station, which may be sent over the regular power lines or over a special control circuit. In such case the operator at the control station determines when the load from the automatic station is necessary and cuts it in or takes it off at will.

Since the operation of all types is practically the same once the initial impulse has been given, a general description of one type will give a good idea of the principles involved. In the wiring diagram, Fig. 3, of a station having a predetermined field setting and designed for continuous operation, a control power transformer *Pt* is connected through suitable fuses to one side of the high-tension alternating-current line to provide power for operating the various devices. The secondary side is controlled by a double-pole, single-throw lever switch *S*. In the diagram, *F* may be a float switch, time switch, a lever switch located in a remote station, or

any device to serve as a master starting element. The starting sequence when *F* is closed is as follows:

The master control contactor *C* is energized and closes, which provides a circuit through the governor solenoid relay *G*, which opens the governor pilot valve, causing the governor to begin opening the gates and starting the waterwheel. By means of an auxiliary contact on *C* and the generator field contactor *E* the exciter rheostat is short-circuited while starting to permit the generator field to build up rapidly.

At about 95 per cent synchronous speed the closing of the speed-control switch *B* closes control-current contactor *A*, which locks in independently of *B*, but dependent on *C* remaining closed. The closing of *A* completes the circuit for closing the oil circuit breaker *O* through the contacts of the exciter relay *R*. The closing of *A* also energizes the time-opening relay *T*. The generator field contactor *E* is operated by exciter voltage and is closed through an auxiliary interlock on the oil circuit breaker *O*. Protection in case of emergency is provided by an under-voltage attachment *V* on the oil switch, and two overload relays *N*. When the field current has built up, the field relay *D* will open its contacts and de-energize the coil of relay *T*. The waterwheel will shut down owing to relay *T* opening if relay *D* fails to operate within the predetermined time setting of *T*. If relay *D* should close its contacts for the time setting of *T* while the machine is running, the station would shut down.

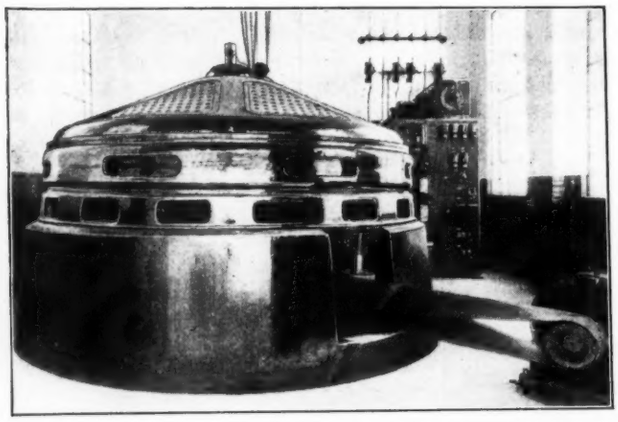


FIG. 4—GENERATOR AND AUTOMATIC CONTROL BOARD, HOLYOKE WATER POWER CO., HOLYOKE, MASS.

Protective Equipment

One of the important features of the automatic station is the protective equipment supplied to prevent damage to the machine in case something goes wrong. The degree of protection supplied depends somewhat on the size of the station, smaller ones not justifying protective equipment as elaborate as that required when the generators are large. Protection for certain contingencies must be supplied in every station, regardless of size.

The troubles and their remedies may be briefly outlined as follows: Hot bearings, which cause the thermostat relays *H* to open the master control circuit, closing down the machine in trouble; overload, in which case, no matter what the cause, the overload relays *N* or thermal relays *J* disconnect the generator from the line; overspeed, when the centrifugal switch *K* disconnects the generator and exciter, and failure of the field which shuts down the station through the action of the field relay *D*. Further refinements in protection consist of differential relays to protect from internal generator trouble, low-voltage relays to prevent single-phase starting or running, and relays for the protection of the generator and exciter from over voltage.

As previously stated, predictions made by engineers concerning the performance and the economies expected of the automatic station have been borne out in practice. In the years since the first stations were installed, much evidence has accumulated regarding their success. In this connection it is sufficient to cite a few examples. It should be said first, however, that so far as estimating actual possible savings in construction of buildings, purchasing sites, etc., with the idea of forming an arbitrary basis of comparison is concerned, this is impossible, owing to the variable conditions in different localities.

The first plant to be put in operation, that of the Iowa Railway and Light Co., has furnished some interesting data on operation. This plant consists of three 500-kw. at 0.80 power factor, 2,300-volt, vertical waterwheel generators which tie in to a system having 20,000-kw. capacity in steam-driven units. The operation is entirely automatic, the generators being put on the line by float switches set at different levels. In about three years after installation the station had delivered over 6,000,000 kw.-hr. with a total cost for inspection and maintenance of only a small fraction of one per cent of the fixed charges.

Another case of interest is that of an installation on the Little Blue River in Nebraska, where the Fairbury Mill and Elevator Co. replaced an old waterwheel equipment with a modern automatic hydro-electric station of two 150-kw. machines. The new station not only furnishes enough power to operate the mill by an electric motor, but supplies power to the city lighting system besides.

Besides these instances, there are many other stations that are accomplishing similar results. In fact, the most conclusive proof that the automatic station is accomplishing that which is expected of it is the fact that it is coming into more general use. At the present time the General Electric Co. has a total of 19 of these stations installed and operating, with an average, excluding two of 4,000- and 5,000-kw. capacity, respectively, of about 470 kilowatts.

As everyone unfortunately is fully aware, the waste gases from a fire where coal or a gas produced from coal is the fuel, might issue from the stack as a dense black smoke. The color of the smoke is due to soot or carbon particles dissociated from hydrocarbons in the flame, but for one reason or another cooled below their ignition point. No matter how bad the combustion, it must be assumed that never 100 per cent of the carbon in the gases leaves the combustion chamber unconsumed; that, in other words, this soot in the waste gases represents only a fraction, even if it is a large one, of the carbon present in the flame and there heated to the temperature of the flame. It is claimed that the actual carbon in dense black smoke amounts to 1 per cent of the carbon in the coal and that this carbon under the microscope appears as clusters of small particles about 0.000002 in. in diameter.—*A. G. Witting*, in a paper, "Judging the Combustion of Gaseous Fuels From Gas Analyses," presented at the 16th annual convention of the A. I. & S. E. E.

Constant Low Draft Over the Fire

How To Find the Actual Saving Obtainable by the Various Methods of Maintaining It

By E. M. ELIOT

THE simplest method of obtaining constant low draft over the fire is to put a fireman at the damper or induced-draft fan and have him change it every time the draft gage moves, so as to maintain the draft at a predetermined figure.

This method is ordinarily too expensive for general use and is therefore not to be recommended, but it is useful as a method of checking the amount of advantage to be obtained from constant low draft. All that is necessary to make the check is to keep track of the percentage of CO_2 in the flue gases, when the fireman is continuously at the damper, and compare this with the CO_2 percentage obtained under normal operation. Fig. 1 illustrates a test of this type, which was carried out on two successive days, for six hours each day. Test No. 1 shows ordinary manual control by the fireman, while No. 2 shows manual control with the fireman continuously operating the damper from observation of the furnace draft gage. It will be seen that the difference in load, on the two days in question, was not great, but there was a marked increase in the percentage of CO_2 in the flue gases and an equally important decrease in the temperature of flue gases. Incidentally, this is a test that can be made by anyone without other equipment than a hand Orsat apparatus for checking the CO_2 percentage. If convenient the temperature can be checked also, but this is not essential for comparative results. Tables and charts are available for converting increase in CO_2 percentage into money for any particular set of conditions.

HERE is the second half of the story started in the Sept. 19 issue. There Mr. Eliot gave the logic of the subject, showing why it pays to maintain a constant low draft over the fire in the case of boilers operating with forced draft. In the present article he takes up the practical application, showing how to determine the saving by actual test and how to figure the most economical method of holding the draft constant.

Another method of obtaining constant low draft is to carry constant loads on all the boilers in a plant except one. The one remaining boiler takes all fluctuations in load. The dampers or induced-draft fans of the constantly loaded boilers are then set for the best draft condition and left that way. The damper or fan on the boiler with changing load is watched carefully and changed when the draft gage shows that the draft has changed.

This method gives fairly good results, but is open to the objection that it is seldom possible to keep the loads and the thickness of the fuel beds, on all boilers but one, so exactly constant that the draft will not vary on any of them. There are many plants where the damper is set for a constant load, in which an exact test, with a fireman at the damper, would show that the draft is not as constant as supposed, and enough excess air enters to cause an appreciable loss of effectiveness. In such cases closer control of the damper or fan would give an increased percentage of CO_2.

A method coming more into use is the employment of automatic apparatus to keep the draft over the fire constant at a predetermined amount. In the past mechanical difficulties have tended to make engineers skeptical concerning the operation of such devices, but these difficulties have been largely overcome, and several good makes of draft regulators are now available. Some of these draft regulators govern the position of the damper or the speed of the induced-draft fan, by controlling these directly from the draft over the fire; others control them from the steam pressure of the boiler or from steam flow in the boiler main. All these regulators change the position of the damper with a change of draft of about 0.02 in., or a correspondingly slight change in steam pressure. Water, air or steam are used as mediums for translating slight forces into forces capable of handling heavy dampers.

In the past the greatest trouble with regulators of this type has been that they hunted or overshot with sudden changes in boiler conditions, but improvements that overcome this defect have recently been made. Some of the regulators on the market include control of the forced-draft fan and stoker fuel feed. It is sometimes advisable to install the three controls—that is, damper, fuel feed and air supply—as a unit, but this is not essential.

Whether it pays to keep a fireman constantly at the damper depends on a comparison of his wages with the savings effected. The percentage CO_2 increase, due to low draft over the fire, should be found by test, converted into terms of furnace efficiency and applied to the coal bill; savings due to decreased flue-gas temperature, indicating better heat absorption, should be estimated; an allowance for longer life of furnace should be made—all of these on the basis of a month or a year, as seems most advisable. The total of these items of saving should then be compared with the fireman's wages for the same period and divided by the number of boilers he can handle. Unless the fireman's pay is below the savings effected, the manual method of control will be unsatisfactory. Usually, this is found to be the case.

Whether it pays to run all of of the boilers but one on constant load and damper position, taking fluctuations in the load on one boiler, depends on a similar comparison.

Each of the boilers should be operated under normal conditions and then with a fireman at the damper. The savings should be computed as between the two methods of operation and the result compared with the cost of other methods of obtaining similar results. It is possible that it might be advantageous to change the method of control for all boilers; or it might be best to change the method for only the boiler carrying

the changes in load; or again, the method described may prove to be the most economical possible. In any event the matter should not be left to guesswork, but carefully tested and figured.

Whether it pays to install a mechanical damper regulator must be decided in the same manner. Savings should be computed as before, but in place of the fireman's wages, computation should be made of the interest on the investment, depreciation and maintenance of, and insurance on, the machinery involved, for the period under discussion. Unless the sum of these charges is below the savings effected, mechanical regulation will not pay. As a rule, on boilers of 1,000 sq.ft. or over, mechanical devices will be found valuable. Under some conditions they may be worth while on boilers of still lower capacity.

A concrete example of computations to determine the value of low constant draft is given in the following: In this case the damper was controlled by a mechanical regulator, which was itself governed by the draft over the fire. Fig. 2 is a CO_2 and draft chart taken at a

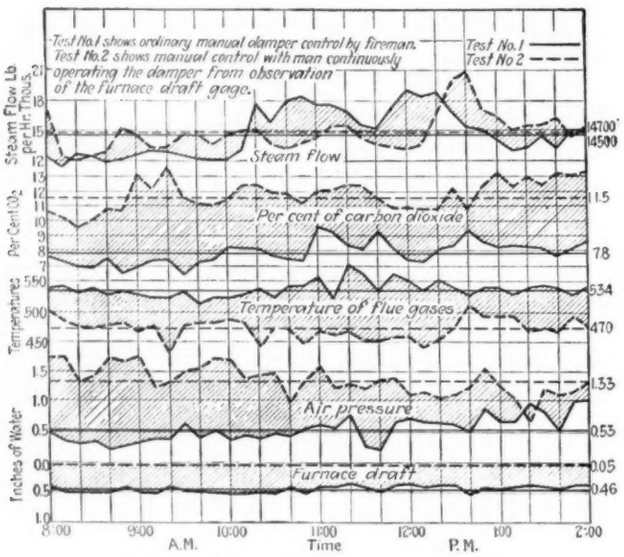


FIG. 1—COMPARATIVE TESTS WITH AND WITHOUT CONSTANT MANUAL REGULATION OF DAMPER

plant where combustion conditions were good, the boiler settings reasonably tight, and all other conditions those of a well-managed industrial power plant. The fluctuations in draft shown were not great, and the CO_2 averaged about 10 per cent.

Fig. 3 represents conditions at the same plant after arrangements had been made to keep the draft constant at a low figure. No change was made in the boiler setting or in any other of the plant conditions. It can be seen that the draft over the fire was kept within narrow limits, and the increase in the CO_2 was between 2 and 3 per cent.

The boiler on which the experiment was made was a 7,000-sq.ft. Stirling unit operating 12 hours a day, 300 days in the year. A good grade of Middle-West coal was used, at $3.80 a ton, and a previously made check of the boiler efficiency indicated an evaporation around 7½ lb. of water per pound of coal. The boiler was run approximately at rating.

Fig. 4 shows certain curves which were available for the coal being used. If the coal used had been an average Eastern grade, chart No. 5 would have been used instead of chart No. 4. The flue-gas temperature, under the conditions of Fig. 2, was 550 deg. F. and under conditions of Fig. 3 it was 480 deg. F., this having been obtained by actual measurement. The combustible in the ash was 25 per cent.

Entering the chart, Fig. 4, at 10 per cent CO_2, and projecting upward to the excess-air curve, it was found

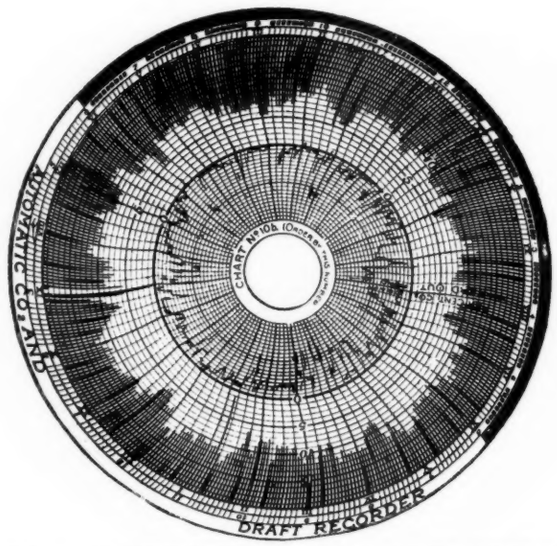


FIG. 2—CO_2 RECORD FROM PLANT UNDER NORMAL OPERATION

that at 550 deg. flue-gas temperature there was 80 per cent excess air and a boiler efficiency of 75.7 per cent. Again entering the same chart at 12 per cent CO_2 and projecting upward to the excess-air curve, it was found that at 480 deg. flue-gas temperature there was 52 per

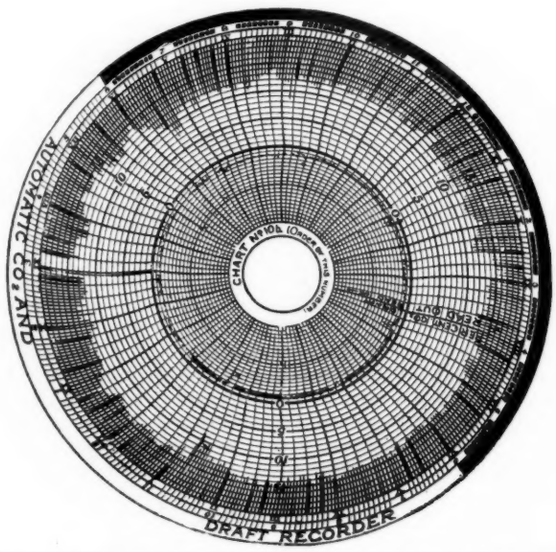


FIG. 3—CO_2 RECORD FROM PLANT OF FIG. 2 WHEN CONSTANT LOW FURNACE DRAFT WAS MAINTAINED

cent excess air and a boiler efficiency of 79.6 per cent. Reducing these two efficiency figures for the combustible in the ash, they become respectively 69.7 per cent and 73.6 per cent. Thus the saving in fuel will be $\frac{73.6 - 69.7}{73.6} = \frac{3.9}{73.6} = 5.3$ per cent. The amount of coal used at 100 per cent rating was 5,040 tons per

year, which, at $3.80 a ton, was worth $19,152. Applying the fuel saving of 5.3 per cent to the value of the coal, the saving per year amounts to about $1,015. As this was more than three times what it had cost to secure a low constant draft over the fire, the engineers were well pleased. The figures given are computed on a yearly basis.

Various objections to the use and value of low constant draft over the fire are urged from time to time and are of interest not only in themselves, but as indicating the need for clearer thinking on this matter if best results are to be obtained in the boiler room. At the risk of repeating some points already mentioned, these are reviewed in the following:

Operators confused boiler efficiency with furnace efficiency. They point to a satisfactory over-all boiler efficiency obtained in a boiler test, and say that they do not believe it can be improved, notwithstanding the fact that the percentage of CO_2 in the flue gases may be 8 or 9.

Over-all boiler efficiency depends on a number of factors, such as cleanliness of tubes, ratio of tube surface to grate area, amount of gases passing through the boiler, etc., as well as on the amount of excess air and the temperature of gases. The draft over the fire affects the last two quantities, and if the excess air can be reduced and the temperature of the gases increased (that is, flue-gas temperature reduced) without increasing losses elsewhere, greater economy of fuel will result whether or not other losses in the boiler are eliminated. As a matter of fact, no other loss is increased by a measurable amount because of carrying a low draft over the fire.

The percentage of CO_2 is the proper criterion upon which to base judgment concerning excess air and draft. If this is increased by any change, it is certain that a saving in fuel has been effected (always excepting the extreme case where CO begins to be formed), whether the result can be detected by a boiler test or not. It is possible that some other loss will increase enough to wipe out entirely the increased efficiency due to better combustion conditions, but this is an argument for reducing such loss to its original amount. It does not in any way reduce the advantage of getting a high percentage of CO_2 in the flue gases nor reduce the financial saving effected thereby.

Operators advance the argument that a high velocity of gases through the boiler is desirable especially to give a scrubbing action, which tends to clean soot from the tubes. They claim that low draft over the fire reduces the velocity of the gases. This has been fully discussed in the previous article, from which it appears that draft does not appreciably influence the velocity of the gases in the boiler except by changing the amount of excess air. When excess air is reduced, velocity is decreased, but this is a desirable condition under ordinary circumstances.

The statement is sometimes made that high draft is wanted at overloads, but whether manual or mechanical means are used for handling the damper or induced-draft fan, it is a simple matter to change the adjustment to a higher constant draft when overloads are expected, and to put it back when the overloads have gone by. Such overloads ordinarily last over an hour and can be anticipated. The draft should not be increased unless lower boiler temperatures are imperatively necessary.

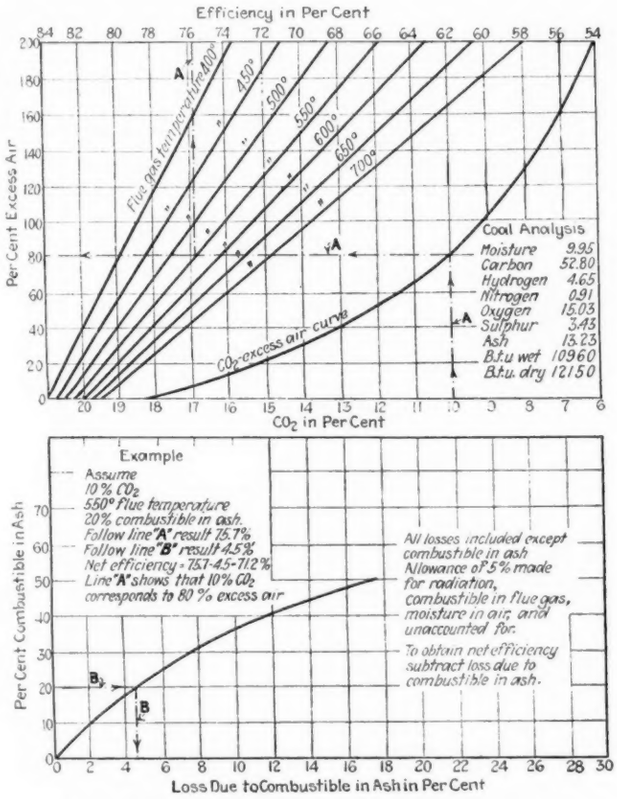


FIG. 4—SHOWING EFFICIENCY CURVES FOR ILLINOIS COAL

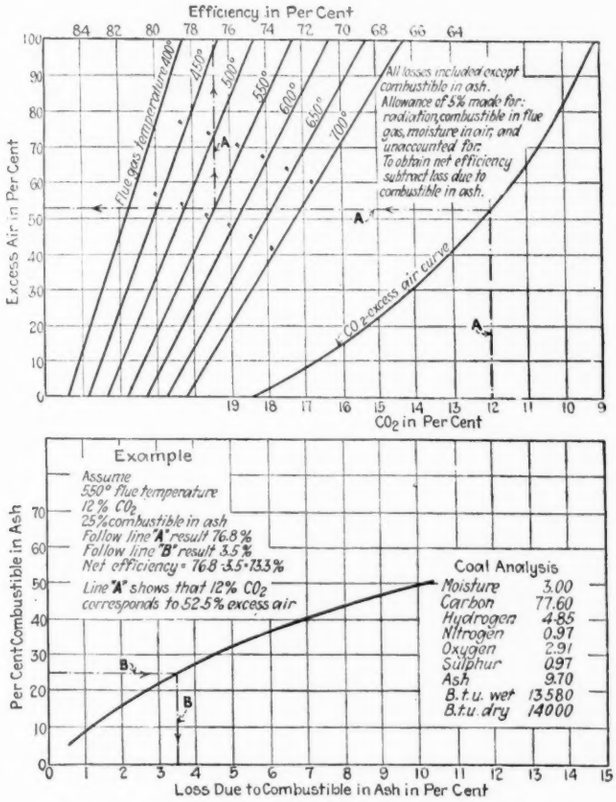


FIG. 5—EFFICIENCY CURVES FOR AN AVERAGE EASTERN COAL

Occasionally, an engineer will state that a low draft over the fire is hardly worth trying for because he is not operating a modern, stoker-fired plant, but a forced-draft hand-fired boiler. The idea seems to prevail that only a plant with all the most modern improvements can obtain advantage from low constant draft.

The fact is that a hand-fired forced-draft installation usually has a lower percentage of CO_2 in the flue gases, and a much higher percentage of excess air than a stoker-fired installation, because constant opening of the firedoors admits excess air in quantities. Therefore, the hand-fired forced-draft installation would profit by draft control more than the stoker-fired installation. The only limitation is that the damper must be set so that it cannot shut completely when the boiler is being fired.

Much Confusion Is Caused by the Term "Balanced Draft"

There is a tendency to call the condition of a low constant draft over the fire "balanced draft." As a matter of fact this term is a trade name and much confusion may be caused by using the term where it is not intended to be used. Sometimes it is used when there is no "balance" whatever. The term should not be used in general discussion of draft conditions.

Sad experience with early types of mechanical regulators have made a good many engineers skeptical as to their value, but improvements in this class of apparatus have changed the situation, and present types should be investigated anew when the question of low draft over the fire is under consideration.

The mechanical cleaning of soot from boiler tubes, the application of forced draft to many installations and better methods of treating feed water have all tended to improve the economy of the boiler plant. Such economy will not be complete, however, until the rather substantial losses due to excess air and irregular temperatures are eliminated by some better means than merely endeavoring to make boiler settings tight.

No attempt has been made to discuss here the relative merits of different mechanical methods of obtaining a low draft over the fire. This is a matter for the engineer to study thoroughly before he makes up his mind concerning the action to be taken. But the general principle that a low constant draft over the fire effects very real economies, with boilers having forced draft, and that satisfactory means are at hand for obtaining this economically, is one which no engineer can afford to overlook.

Economy Versus Efficiency

By T. A. Marsh*

Engineers have devoted so much thought to developing higher efficiencies that they have in many instances lost sight of the real ultimate aim—high economy. It is possible to have high efficiency with low economy and high economy with low efficiency. The former is undesirable.

Consider a boiler plant using coal at $4 per ton and burning it at 70 per cent efficiency, as compared with a possible $2 per ton coal which can be burned at only 50 per cent efficiency. If the coals are of similar heat content, say 11,000 B.t.u. per lb., 1,000 lb. of steam in the first instance will cost, say, 25c. and in the latter case, even though operating at lower efficiency, the steam will cost 15c. per 1,000 lb. It is evident that it would be good economy to burn the latter coal even if it were inferior in quality or if the efficiency of combustion and evaporation were lower than 50 per cent.

Large central stations sacrifice efficiency for economy every day in numerous ways. High boiler ratings are carried over peak-load conditions with definitely lower efficiency in order to produce cheaper steam throughout the entire 24 hours by using a less number of boilers and thereby reducing the investment capital and charges, operating charges and the stand-by losses on additional units. Such stations also lose heat in the circulating water used for condensers. The efficiency of power production would be higher if this heat were saved, but power-station economy will not permit the investment for and the operating charges of the equipment necessary to reclaim such heat. Therefore, B.t.u. are wasted to save money. No one is interested in operating with fewer pounds of coal if the cost of steam or current is going to be higher in dollars and cents.

Usually, oil can be burned at higher efficiency than coal, but the cost of the oil is such that in most localities its use results in increasing the cost of producing steam.

Examples can be cited indefinitely where capital charges and operating costs more than offset the advantages of higher efficiency from the apparatus. There is also that class of apparatus that gives high efficiency from a gross standpoint, but entails auxiliary and operating charges that reduce the net of useful work to a point where the economy is low. This is high apparent efficiency and low economy, or in other words, low net efficiency.

Reliability Should Be the First Consideration

It must be recognized always that the factor to be given first consideration in power-plant equipment is reliability. This is true directly from the viewpoint of economy. Unreliability means low economy due to loss of revenue and continuation of fixed charges while the apparatus is out of service.

It is not denied that high efficiency and high economy may, and frequently do, go hand in hand, but this is not always the case, nor is it even usually the case beyond a certain point. A certain percentage of efficiency can be obtained at a reasonable cost, but any increase in efficiency beyond this point comes with such effort of either unreliability, preparation cost, capital charges, operating charges or maintenance that it entails low economy, and engineers attempting such performance are eventually discredited as being poor business men.

Some features of high efficiency with poor economy in power-plant equipment and design are not so definitely marked as those mentioned. Certain features may indicate good economy in some localities and with other conditions of load and coal be uneconomical in other instances. Each piece of apparatus should be investigated and scrutinized carefully and the answer should be found not to the question, "It is the most efficient piece of apparatus," but "Is it the most economical?" Engineers must analyze and discriminate between those things that definitely save money and those things that simply appear to save money. To apply a much-worked expression, we need "More engineering in business and certainly more business in engineering."

*Chief engineer, Green Engineering Co.

Chasing Oil Engine Troubles

By M. S. HOWARD

IT HAS been my experience as a trouble man and erector for a Diesel engine builder that the majority of engine trouble cases are the fault of the operating engineer. The average engineer does not know enough about the principles upon which the successful action of the engine depends, and for some reason seems unwilling to learn how and why the machine operates.

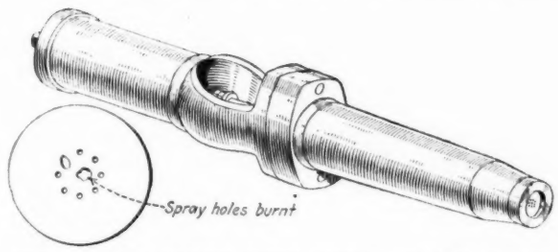


FIG. 1—FUEL VALVE WITH BURNT FLAME PLATE

Too many of these men think that since they have repaired an automobile engine, they know all there is to know about oil engines.

Usually, the troubles that seem to be beyond the ability of the operator to correct are due to simple causes—so simple that one would think any intelligent engineer could reason the matter back from effect to cause.

Not so long ago I was ordered to go to a town in Kansas where, in a plant having two Diesels, a considerable amount of trouble was being experienced. Upon arrival at the plant, which supplied the town with light, I found that one engine was down and the engineer badly scared.

Explosion in the Air Line

He reported that there had been an explosion in the injection air line leading to one of the spray valves. Since a piece of the spray-valve spring case had struck him on the leg, he was, to say the least, agitated. His general attitude was that the engines were possessed of a demon and were liable at any time to get up and walk off the place.

Luckily, there was a spare spray valve and cage as well as some air and oil piping, or rather tubing. I buckled in and soon had the valve cage in the cylinder head. By hard work I was able to cut and fit the air and oil lines before night. Checking the valve timing and giving the engine a brief inspection took all the time left before the hour for putting it on the line to carry the heavy evening load.

The engine behaved in a rather unsatisfactory way. Sharp pounding or preignition took place in each cylinder at various times, and the exhaust temperature frequently ran very high. The engineer explained that this pounding was an every-night occurrence on this particular engine and that once in a while it happened on the second unit. He also stated that at times when the pounding was bad, the engine would slow down enough to cause the relays to kick open the circuit breaker. We nursed the engine along until midnight and then shut it down until morning.

Next morning the engine was started and soon began to pound. The pound was sharp and entirely unlike the heavy dull pound that takes place when the bearings are slack. It had all the appearance of preignitions or oil explosions in the cylinders before dead center. Since the oil is not blown into the cylinder of a Diesel until practically dead center, under normal conditions there can be no preignition. One was safe in concluding that through some misadjustment oil was entering the cylinder earlier than usual.

Flame Plate Was Burned

We proceeded to remove all the spray valves and cages. I found at once that the flame plate on one spray valve was burned, as in Fig. 1. This flame plate carries a number of holes through which the oil is blown into the cylinder. Two holes in the plate had edges that bore evidence of having been hot enough to melt the metal. Now with the engine running under usual conditions, although the flame plate is exposed on the outside to the temperature of the burning fuel in the cylinder, the plate never gets very hot. This is because the charge of cool air and oil passing through the holes at each injection period keeps the plate cool. The condition of the burnt holes indicated that the flame had passed from the cylinder into the spray-valve casing. This was evidently the cause of the exploded spray valve and air lines. There was no doubt that somehow the flame from the burning oil in the engine cylinder had passed through the flame plate into the spray valve and had ignited the oil that was resting in the cage. The resulting explosion had blown the cage to pieces. Why or how the flames could flow backward through the flame plate was the puzzle.

It was first assumed that something had held the spray needle valve open during the time it should have

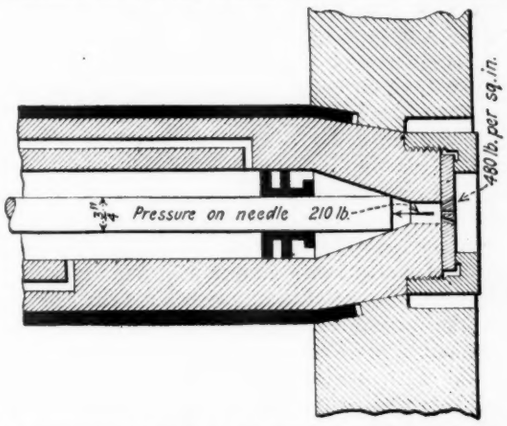


FIG. 2—ILLUSTRATES PRESSURE UPON NEEDLE

been held closed. I examined the needle-valve stem for signs of corrosion which might, by friction at the packing, hold the valve from closing. The needles were all in good condition and so other causes were searched for. The engineer offered the information that the needle-valve stuffing boxes were hard to keep tight and that he had to tighten the gland frequently. He had, so he said in answer to the inquiry, never renewed the packing, although the engine had been in service for two years.

This might cause the wedging open of the needle if the spring tension was weak.

On taking the valves apart, I found that there was but little initial tension on the spring. The engineer's excuse for so weak a tension was that if the spring tension was made very high the valve seemed to jump when it hit the seat and that two valve cages had been ruined by the needle burying itself in the seat. So to avoid this damage he had set the spring so that the needle would close when jumped, with the engine at rest. He had failed to consider that when the engine was not running, all the spring had to overcome was the frictional resistance of the stuffing box. When the engine is running, the combustion pressure of, say, 480 lb. per sq.in. is exerted upon the end of the needle-valve stem, as in Fig. 2. This needle is $\frac{3}{4}$ in. in diameter, which means that a total pressure of 210 lb. tends to force the needle open and is resisted by the spring tension only. With little tension it is clear that the needle would be pushed open as soon as the compression pressure was enough to overcome the spring resistance. The oil spray would enter the cylinder before dead center, causing the preignition.

Now all this solves the pounding troubles, but does not explain the reason for the fire blowing back into the fuel valve. As long as the air at 900 lb. pressure is exerted on the oil in the fuel valve, it is impossible for the flame to flow back against the stream of high-velocity air and oil. Feeling that this would be solved sooner or later, we put in a new flame plate, repacked all the needle stuffing boxes and adjusted the springs to give a high tension. The engine was started up and ran fine; the preignitions had disappeared, and the engineer felt we had settled all his troubles.

Cause of Low Air Pressure

As a safeguard the fuel valve on the cylinder where the valve cage had exploded was removed again, and to our surprise the flame plate showed one hole burnt. Now I had been particular to see that the injection air was held at 900 lb. during the trial run, and it was puzzling how the flame could flow back against this pressure. The next question that came to me was, Did the air pressure actually stay at 900 lb.? So I removed a pressure gage on one of the air receivers and replaced it with one out of my tool chest. To my astonishment the pressure showed 925 lb. It looked as if we were stumped. My deductions apparently fell dead. However, the argument of low air pressure was a good one, and on second thought the fact that the receiver pressure was high did not prove conclusively that the pressure in the fuel valve was not low. We took off the admission-valve cage so that we could hear the rush of air into the cylinder. By pulling a bar under the fuel valve rocker, the needle valve was opened. The air rushed out with a high velocity at first, but instantly dropped to the merest blowing. Clearly something had acted to retard the flow. Upon taking down the air line a lump of substance that almost closed the passage was found in the air-check valve just before the air line entered the fuel valve. This proved to be a ball of solder. The line had soldered connections in several places, and the erector had carelessly allowed some to drop into the pipe.

The explanation was that there was enough room around the ball of solder to allow the air to flow to the valve, building up the pressure while the engine was on the suction and exhaust stroke; but as soon as the needle was opened, the air pressure dropped and became less than the cylinder pressure. The flame then flowed back into the fuel valve casing and burnt the flame plate and caused the explosion.

The engineer was not responsible for the burning of the first flame plate nor for the first case of preignition, but he should not have permitted these to occur a second time. By ignoring these initial signs of engine trouble, an accident was allowed to occur and it was by mere chance that the explosion caused no loss of life.

A steam engineer, upon taking charge of an oil-engine plant, should take nothing for granted. He should study the principles of the engine, learn how and why it runs and what will prevent the machine from functioning in a proper manner.

New Knife-Blade "Buss" Renewable Fuse

A new fuse designed to insure quick and easy renewal has been recently placed on the market by the Bussmann Manufacturing Co., of St. Louis. As shown in Figs. 1 and 2, the two terminals are held together by a permanent terminal support consisting of a fiber bar *A* and brass jumpers *B* which hold the bar alongside the wall of the fiber tube. The renewal link *C*, which is slotted at each end, slips under the terminal

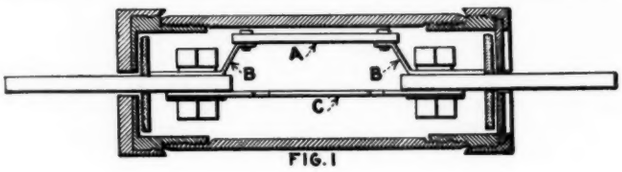


FIG. 1

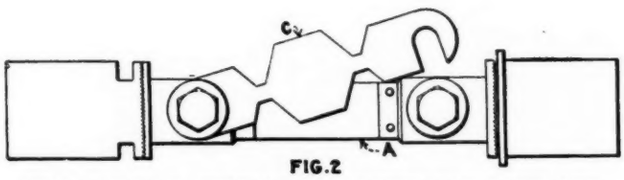
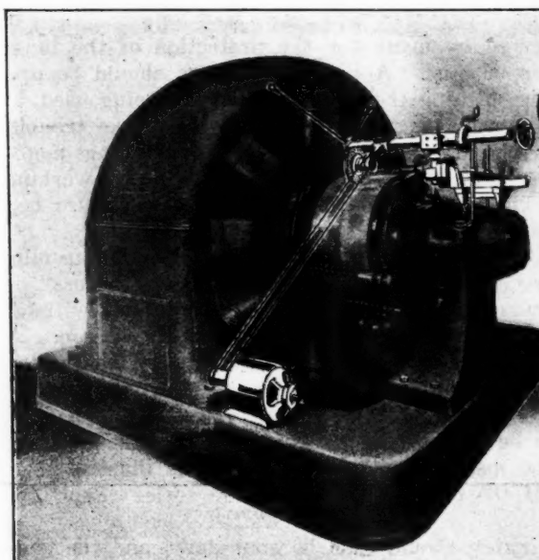


FIG. 2

FIGS. 1 AND 2—SECTION OF RENEWABLE FUSE AND FUSE ELEMENT

bolt heads and washers. The bolts do not have to be removed; they are simply tightened after the new link has been slipped in place. To the tube there is only one removable cap; the other end has a revolving cap which rides a quarter turn and locks in place when the removable cap is screwed on. Alignment of the terminals is secured by having one of them seated in a slotted opening while the other is lined up by projections on the venting disk fitting into notches in the end ring.

To minimize the amount of metal volatilized on the blowing of a fuse, the renewal links are made with two or more narrow sections. When the fuse is blown, only the narrow sections burn out, so that pressures great enough to burst the case are not developed and there is no need for an arc-extinguishing filler. Instead, a venting system is provided by knurled cut disks attached to the terminals and spaced so as to fit snugly to the inner faces of the closures. The gases pass through these shallow grooves, and there is just enough clearance at the terminals for them to pass out with the flame muffled and quenched, while with the exit restricted, sufficient pressure is retained within the inclosure to help extinguish the arc.



Grinding Commutators and Collector Rings—

Hints on Grinding

By Eustis H. Thompson*

ORDINARY grinding devices use wheels 6 in. to 10 in. in diameter, ½ in. to 1 in. thick, ½-in. to ¾-in. bore. Such wheels are made by a large number of manufacturers. The most important feature of a grinding wheel is to have the hub offset or else provided with a counterbore so that the screw or bolt for holding the wheel in place will not extend beyond the face of the wheel itself, but will be contained within the recess thus provided, as shown in Fig. 1.

Avoid Low Cutting Speed

The success of a grinding wheel depends principally on using the proper cutting speed. The travel of the commutator in feet per minute added to the travel of the wheel running in the other direction is the actual cutting speed and may equal 7,000 to 8,000 ft. per min. very satisfactorily.

Commutators usually operate at 2,000 to 3,000 ft. per min., so that for good service the wheel speed should amount to 5,000 or 6,000 ft. per min. when running in opposite direction to the commutator at full speed. In speaking of the wheel speed, the Norton Company advise that "the best cutting speed is from 5,000 to 6,000 ft. per min. No great gain will arise in using 7,000 ft. per min., but with the elastic process wheels the grinding wheels themselves can be run as high as 7,000 to 8,000 ft. per min. with safety." It is very necessary *not* to use a lower cutting speed than advised because in such cases wheels will not cut freely and will wear away rapidly, which greatly prolongs the job. In case the commutator speed itself is high, the total actual cutting speed, which represents the sum of these two, may be considerably in excess of 8,000 ft. per min. It will then be found that a fairly slow speed on the grinding wheel will give best results. The wheel speed must be determined by the judgment of the operator. In grinding hard collector rings, which ran in excess of 9,000 ft. per min., the writer found good results by allowing the grinding wheel to run without power so as to be driven by the collector rings. A slight friction was then applied to the wheel, so as to slow it down, and when the actual cutting speed, or in other words, the difference in speed between the collector rings and the wheel reached a certain amount, first-class cutting was produced.

For commutators of the usual surface speeds, the following speeds for the grinding wheel are recommended:

Diameter of Wheel, In	R.P.M. of Wheel
4	5,200
5	4,200
6	3,500
7	3,050
8	2,500
10	2,100
12	1,750

Wheels of special material are necessary for grinding commutators. Wheels suitable for iron or steel will not do for this work as they tend to "pick up" copper, so that getting rid of this copper dust, or the prevention of "loading" the wheel, is the great problem in such work. Wheels made of the trade material known as "No. 66 Alundum" are used to a large extent, especially when bonded by the elastic process. Manufacturers furnish various grades for roughing and smoothing. The roughing wheel is principally used.

This will also cut hard collector rings at approximately one-quarter less speed than for copper.

In mounting the wheel on the device, be sure that the bolt for holding the wheel in place should have the thread in such a direction that the friction of grinding will tend to tighten the bolt and therefore hold the wheel solidly. Otherwise the wheel will ordinarily work loose and require frequent tightening, or perhaps cause damage. The shaft containing the grinding wheel should be fitted with a right-hand thread in one end and a left-hand thread in the other end, so that either type of bolt can be used according to the direction of rotation of the wheel that is desired. The shaft may be reversed end for end, depending upon the position required by the wheel.

Wheels usually run out of true when first tried. They soon wear to a true surface so that an even cutting on the commutator is assured.

Lining Up the Grinding Device

After the grinding device is mounted, it should be lined up with the commutator. The guide bar or plate should be set in the same plane with the shaft. This can be done by sighting from a short distance, over the

*Associate editor *Power*; formerly of Construction Department, General Electric Company.

guide to a commutator slot. The guide should be mounted so that it is parallel to the slot as near as the eye can conveniently locate it. The guide should now be set parallel with the shaft measured radially, or in other words, parallel with the commutator surface. One way to do this is to use a caliper between the guide at each end of the commutator, so that these two dis-

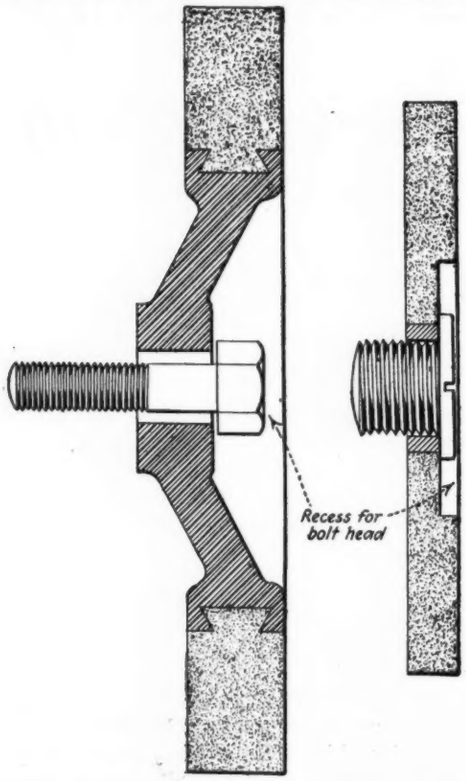


FIG. 1—GRINDING WHEELS WITH RECESSES FOR BOLTS

tances are approximately equal. A more convenient method is to mount the wheel and feed it in so that it almost touches one end of the commutator. Adjust the wheel radially so that a wooden rule or piece of fiber can easily be slipped between the wheel and the commutator bar. Feed the carriage to the other end of the commutator without changing the radial feed of the wheel in or out, and insert the rule or fiber as before. When the device is parallel, the shim can be slipped in with equal binding at both ends. If it is tighter or looser at one end than at the other, it indicates that the device is out of parallel accordingly. It is not absolutely necessary to have the device perfectly parallel, but it should be as near as easily possible. The pull of the belt may tend to throw it out of parallel. The guide can be set a trifle closer at one end to compensate for the pull of the belt if necessary.

Ball bearings are usually provided for the wheel shaft. There should be absolutely no lost motion. End play is not especially important, but a loose bearing will make a series of high and low spots. An extra set of bearings is desirable in case of trouble while grinding. These bearings must be kept absolutely clean.

Oil up before going further.

Points on Grinding

For medium or large commutators a pair of goggles is a great convenience; for short jobs ordinary glasses are sufficient. When a large commutator requires eight or ten hours' grinding, an air filter worn over the nose is preferred by many for the protection of the lungs from copper dust. A new paint brush should be provided for cleaning the device while it is being used, as there is always a great deal of dust to make trouble.

After the device is lined up, the grinding motor should be run up to speed and everything put in working order. The speed should be checked and the motor belt adjusted if not satisfactory.

Travel stops are often very convenient. It is usually necessary to feed the wheel as close to the "risers" or "end conductors" of the armature as possible without actually touching them or the protecting screen. A travel stop may be set which will block the feed at the desired point, preventing feeding of the wheel into the armature "risers." With a bar-type machine a split ring can be clamped in the guide to limit the feed. A plate-type machine with a travel stop is illustrated in Fig. 4 of the previous article of the series (Sept. 19, 1922).

The rigging should then be shut down and the generator brought up to speed. When this step is satisfactory, the grinding motor should again be speeded up and the work of truing up begun.

Grind Out High Spots First

Do not dig in hard with the wheel. Use a light free cut and take off the high spots first. One of the secrets of doing a good job is to leave the low spots in the commutator until last. The high surface can be taken off

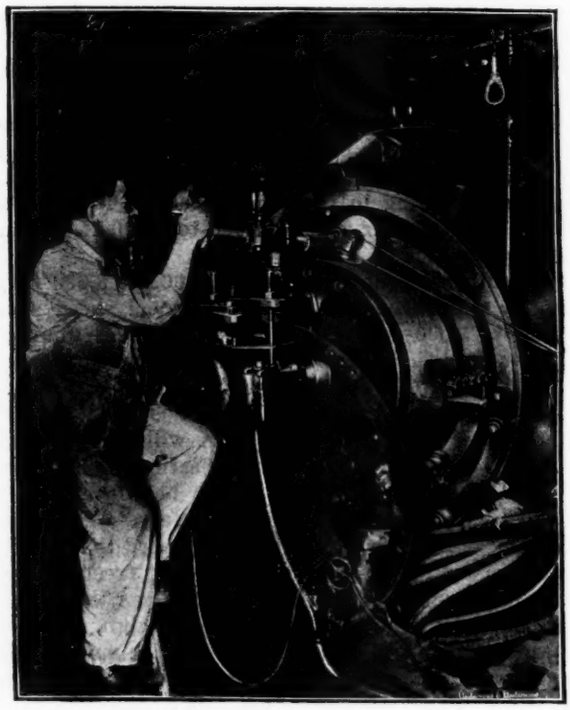


FIG. 2—GRINDING IN PROGRESS

in an even manner, and when the low spots finally disappear the surface will be true. If the wheel is started on a low spot and kept there until it disappears, it usually happens that the low spot is only brightened up so that the actual surface is not true on account of the high spots not being ground to the necessary extent, there being nothing to indicate otherwise. By leaving the low spots until the rest of the commutator is reduced to the required extent, the low spots can then be taken out with very little application of the wheel.

A finer-grade wheel is often used for finishing a commutator. Two or three cuts over the surface with the fine wheel is usually sufficient. In order to obtain a bright smooth surface, finishing with a sand stone, or abrasive block, naturally suggests itself. This course, however, is not advisable as a stone held in the hand is likely to cause small flat spots in a high- or medium-speed commutator. In ordinary cases it is better not to use even sandpaper, and the finishing wheel can often be dispensed with to advantage. A commutator that has been ground will ordinarily take as good a polish in a week's operation as it would if a first-class polish had been applied. When several commutators have been finished in different ways together with one or two left unfinished, and are operated for a little while, it soon becomes impossible to tell which received the best polish originally.

With regard to the time and material required for the *actual* grinding, it may be estimated that a small commutator one or two feet in diameter would take from one to four hours. Commutators six feet in diameter would be expected to take from one to four days. In the latter case the wear would probably be from one to two roughing wheels if used under the proper conditions. When the cutting speed is too low, a wheel will wear down sometimes in one hour, with very little removal of the copper.

Cleaning and Assembling

Copper dust cannot be blown with compressed air satisfactorily. It is best to wipe the machine with brushes or rags and remove practically all copper dust before blowing with air.

Commutators should be inspected, in the case of undercut mica, to see if mica comes to the surface in any place. High spots of the mica should be removed with an undercutting file or a pointed tool to a depth of about $\frac{1}{32}$ in. When commutators need to be entirely undercut, this work should be done first and then followed by grinding; $\frac{1}{32}$ in. is the depth usually preferred for undercutting, as greater depth collects dirt.

In the case of a generator it is usually advisable to make sure that the bars are not short-circuited by copper dust. The slots should be looked over carefully and cleaned with a piece of wood or fiber in case dust is collected there. In order to make sure of clean slots, any remaining copper can be easily burnt out by applying voltage to the machine. Bring the generator up to speed before the brush rigging is assembled, or else with one armature line disconnected from the brushes and insulated from frame or other conductor. Place fuses to carry the field current across the jaws of each line switch, turn the field rheostat "all in" to the "no voltage" position and close the circuit breaker. Gradually turn the rheostat back and build up a field to the normal-voltage position of the rheostat. Any copper dust will be burned out without harming the machine.

Such a proceeding is not necessary in a motor.

The brush rigging can now be completely assembled and the brushes fitted with sandpaper, and the machine made ready for service, after a good cleaning up.

Commutators are often ground in a lathe. Manufacturers of grinding apparatus, cylinder grinders, etc., have many types of grinding devices suitable for mounting in a lathe.

Commutators were originally smoothed up with sand stones or various grades of polishing stones. For surfacing a commutator, a stone that can be clamped in a turning device and fed across a commutator, similarly to a turning tool, has been developed by manufacturers of abrasives, as well as special bricks to be held in the hand, for polishing commutators. High-speed commutators, which could not be trued up successfully with a turning device on account of the low speed necessary in using a tool, have, at times, been made to operate well by being trued up at normal speed with an abrasive brick clamped in a rigging. This method requires great rigidity and in general is not as sure or satisfactory as using a grinding device with a rotating wheel. An abrasive brick, however, can be used with great success in a lathe toolpost, on a commutator of an armature that has been rewound, when the surface is only slightly rough. In this case a thorough finish can be quickly applied in the lathe, at much less cost than by turning or grinding with a revolving wheel.

Abrasive bricks are sometimes of great value when the commutator of a small motor is in bad shape and conditions will not allow the time for turning or grinding. An abrasive brick with handles attached for applying it, can be used to put the commutator in good shape, so that operation may be continued by occasional applications until an opportunity occurs of truing the commutator with a tool or wheel. An abrasive brick can be used to advantage after a flash over, when it is desired to get the machine in operation as quickly as possible.

Sandpaper should never be used on a commutator except for the lightest kind of a polish. Sandpaper will not cut mica satisfactorily, in case of high mica or commutators in which the mica is full. It is more useful when withheld from a commutator altogether.

The author is indebted to W. T. Montague, sales engineer of the Norton Company; the Jordan Bros., of New York City; and W. P. Poynton, consulting engineer, of Pittsburgh, Pa., for their kind assistance.

Our Coal Reserves

As a conclusion to the chapter on fuel conservation, the new book, "American Fuels," by Bacon and Hamor, makes the following estimate of the situation:

"The question is likely to arise, whether fuel conservation is of great importance when supply is ample, transportation is adequate and profits of fuel users are apparently secure. First, it may be answered, efficiency in the use of raw materials always makes for increased financial returns; second, waste promotes extravagance and raises the cost of living; and lastly, our high-grade fuel reserves are being exhausted at an alarming rate. George H. Ashley, State Geologist of Pennsylvania, estimates that practically all the easily workable coal beds of Pennsylvania and West Virginia, 6 ft. or more in thickness, will disappear in 75 or 80 years at the present rate of increase in exhaustion. Low-sulphur coals, especially desired for metallurgical purposes, are becoming so scarce that steel men are investigating measures for getting along without them. Yet the high-grade low-sulphur Pocahontas and New River coals still are sold in large part for steaming purposes, where such low-sulphur content is not an essential quality.

"Improvement nevertheless is being made in the direction of systematic and logical coal marketing and higher efficiency in utilization; there is a progressive tendency, in America, toward greater fuel economy, and future developments may decrease materially our per capita fuel consumption."

Corrosion—Its Cause and Cure

THE metal lost each year in this country by corrosion amounts to many thousands of tons. As the average piece of equipment must be sent to the junk heap when no more than a fifth of its weight has been lost by corrosion, each pound of metal thus

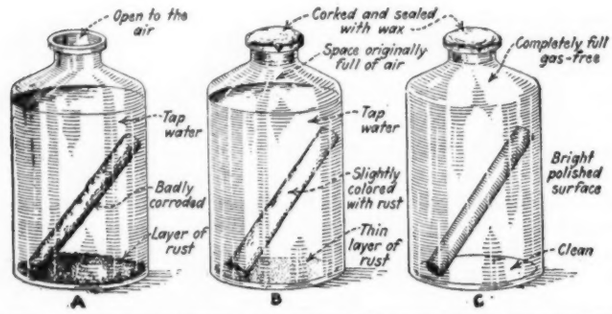


FIG. 1—EXPERIMENT TO SHOW CONNECTION BETWEEN CORROSION AND DISSOLVED OXYGEN

removed causes a loss at least equal to the erected cost of five pounds of the original equipment.

Although bridges and other exposed steel structures are preserved by painting at regular intervals, it has not generally been considered practicable to apply a protective coating to the interior surfaces of piping, boilers, etc.; but the problem has been successfully attacked from another angle. The general method is to remove the corrosive elements from the water, it having been demonstrated that water alone does not cause appreciable rusting or corrosion.

THIS is the third article* of a series on feed-water treatment, and the first of two dealing with corrosion. The present article starts with a general discussion of corrosion as found in power plants and then describes a European type of apparatus for its prevention. With this as an introduction to the subject, the second installment will explain the construction and operation of American-made equipment for the elimination of corrosion.

The theory of corrosion is so difficult that experts still differ as to the exact nature of the changes that take place. It has, however, been established that the corrosion of commercial iron and steel by ordinary water is due almost entirely to dissolved oxygen. Some experts claim that the action is electrochemical, the oxygen acting as a depolarizer. Others say that the oxygen attacks the iron directly. For practical purposes the important thing to know is that, in the great majority of cases, corrosion will stop if the water is freed from dissolved oxygen.

The basic facts are easily illustrated by a simple experiment, as follows: Three bright pieces of iron or steel are placed in three large bottles, *A*, *B* and *C*. The bottle *A* is filled with ordinary tap water and the cork is left out so that it is exposed to the air. Bottle *B* is nearly filled with tap water, but corked, and the cork is sealed with wax so that no outside air can enter. No attempt is made in this case to remove any air that is over the water in the bottle when it is sealed up. Bottle *C* is completely filled with tap water from which the dissolved oxygen has been removed. This bottle is sealed in the same way as bottle *B*.

If, now, these bottles are laid aside for a year or two and then examined, the following is found to be the case: The iron in bottle *A* is heavily rusted or corroded, and the bottom of the bottle is covered with a large amount of rust. The continued corrosion in bottle *A* is due to the fact that the three necessary constituents (water, oxygen and iron) have been continually present. As fast as the oxygen originally in the water was used up in maintaining the corrosion, the water absorbed new oxygen from the air to which it was exposed.

The iron in bottle *B* is found to be covered with a thin layer of rust, but the corrosion is practically nothing in comparison with that in bottle *A*. The reason is that corrosion in bottle *B* lasted only as long as the oxygen originally dissolved in the water and present in the air above the water. When this was used up, corrosion stopped.

The iron in bottle *C* is found to be free from corrosion; in fact, it is practically as bright as when originally put in. This is simply due to the fact that there has never been any oxygen along with the iron and water in the bottle.

From what has already been said, it is evident that if the oxygen can be removed from the water and prevented from re-entering it, corrosion difficulties must ordinarily cease. Fundamentally, there are two ways of removing oxygen from water. One of these is chemical in nature, but involves no chemical processes as commercially understood. The basic idea of this method is to bring the water into contact with a mass of replaceable iron or steel having a large surface. In this way the oxygen can use itself up on low-priced metal, which, of course, is heavily corroded

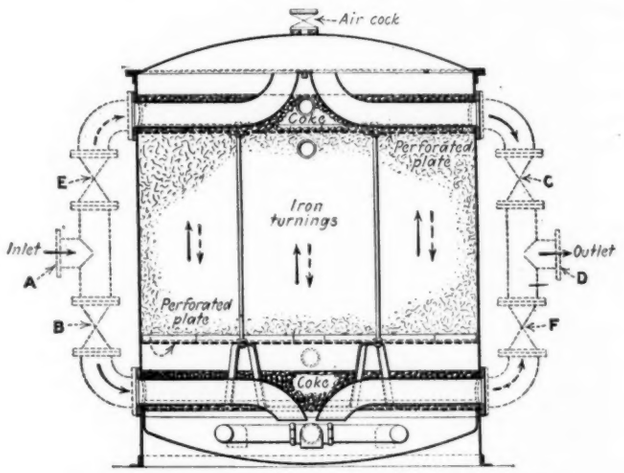


FIG. 2—CROSS-SECTION OF KESTNER DEGASSER

and must be replaced from time to time. If the water is left in contact with this metal until corrosion ceases, it is evident that it must lose its power to corrode the pipes, boilers, etc., through which it passes later.

*The first article (Softening Water with Zeolites) appeared in the Sept. 12 issue, and the second (Evaporators in Stationary Power Plants) in the Sept. 19 issue.

It may be mentioned in passing that the rate of corrosion is much accelerated if the water is hot. Therefore, it is customary to carry out this process with hot water so as to reduce the time during which the water must be left in contact with the iron, and thereby reduce the size of the necessary apparatus.

Another great advantage of preheating the water is that this drives off a large part of the air, thus reducing the amount of oxygen to be removed by metal. This not only permits the use of smaller and cheaper apparatus, but also greatly reduces the metal consumed.

The corrosion method of removing oxygen from boiler-feed water is exemplified in Europe by the Kestner process and in America by the Speller process. The latter will be described in the next article on Corrosion.

Fig. 2 is a cross-section of a Kestner "degasser," which is nothing but a tank full of steel turnings, and provided with valves and piping such that the feed water may be passed through the bed in either direction at will. For reasons that will appear later, the bed of iron turnings is made sufficiently thick so that the removal of oxygen is complete by the time the water has passed half way through it.

Suppose the degasser is to be started with an upward flow. Valves *E* and *F* are kept closed, while *B* and *C* are opened. The water, entering at *A*, passes through *B* to a distributing pipe at the bottom of the degasser. From this it passes up first through a bed of coke, which serves to secure uniform distribution over the whole area. It then goes through a perforated plate and the bed of iron turnings to another perforated plate and layer of coke at the top. From this it passes through *C* to the outlet *D*.

The coating of rust that forms on the turnings in the lower half of the "degasser" gradually slows up the action, because it blankets the active metal beneath. To clean off most of this rust, while continuing the operation of the apparatus, the flow of water is reversed by closing valves *B* and *C* and opening *E* and *F*. This gives a downward flow through the turnings, so that the upper half is active in removing oxygen while the turnings of the lower half are surrounded by oxygen-free water. Under these conditions the red rust on the lower turnings is gradually reduced to a greenish-black rust that is easily washed away, leaving the metal surface exposed ready for rapid action.

By reversing at suitable intervals, this cleaning process may be continued indefinitely. It should be noted that the reversal does not reduce the consumption of metal, but merely speeds up the action in the half that is removing oxygen. This method of operation, on the other hand, uses only one-half the exposed metal surface at any one time.

The turnings consumed usually save five times their weight of the much more expensive metal of the piping, boilers, drums and tubes. As the corrosiveness of iron or steel varies greatly with its chemical composition, it is considered desirable to use turnings especially adapted for this kind of work in order to get the maximum capacity. A certain grade of manganese steel is recommended for this purpose because it corrodes rapidly.

The Kestner degasser is ordinarily used in connection with the Kestner continuous feed-treatment and blow-down system. This system, involving lime and soda treatment for hardness and continuous blowing down of "distilling" boilers with recovery of most of the soda used, will not be described here.

In this and any other system of degassing great care must be taken not to let air come in contact with the water after the oxygen has been removed. If it is necessary to operate any parts of the system beyond the degasser under a pressure below atmospheric, these parts must be gastight. In such cases it is safest to have the degasser located close to the boiler, thus reducing the danger of air leakage.

An early issue will contain the second article on corrosion. This will describe the construction and operation of several types of American-made apparatus for removing the corrosive elements from feed water. Some of these, as in the case of the Kestner degasser, just described, allow the oxygen to use itself up on a mass of iron or steel. Others work on an entirely different principle—that of releasing all the gases (including oxygen) by a sudden reduction in pressure below that corresponding to the temperature of the entering water.

Still others release as much of the total gases as possible in an open heater and then use iron or steel to remove most of the remaining oxygen.

Cause of Carbon in Air Compressors

By W. F. OSBORNE
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WHEN a lubricating oil, composed of carbon and hydrogen, is subjected to heat and pressure, it tends to decompose with the formation of free carbon. The rate of this decomposition increases as the temperature and pressure are raised. The amount of decomposition depends also upon the length of time the oil is exposed to the action of heat and pressure.

Even at temperatures as low as 200 deg. F. it is possible with most oils to get a certain amount of carbonization provided the oil is subjected to this temperature long enough. On the other hand, almost any oil can withstand a very much higher temperature provided it is removed quickly before decomposition has started to any great extent.

Lubricating oil supplied to an air cylinder is vaporized and atomized by the swirling action of the air and is carried to all parts of the cylinder and valve chamber. The only way the oil can get out of the cylinder is through the air-discharge valve. This means that any oil that is not quickly atomized or vaporized will remain in the cylinder for a considerable time, and there will be an accumulation of liquid oil in all depressions on the cylinder and piston heads, discharge valves, etc.

Since the oil is a mixture of a number of hydrocarbons of different boiling points, some of the constituents will vaporize at the temperatures within the cylinder, others will not. The vaporized portion of the oil goes out through the discharge valve. The heavier stickier portion, which remains in the cylinder, collects on all metal surfaces not rubbed by the piston. From continued exposure to heat and pressure this oil slowly

decomposes, and a sticky, adhesive mass of carbon and oil builds up.

If all the oil were evaporated or atomized by the air and carried out of the cylinder as soon as it had done its work of lubricating the cylinder, there would be little opportunity for carbonization to occur. Such being the case, an oil of a fairly high volatility will evaporate more quickly than one of lower volatility and will be carried out of the cylinder more quickly. A blended oil, one composed of a low-viscosity oil and a high-viscosity oil, has such a wide range of evaporation that the lower boiling-point hydrocarbons are quite likely to evaporate leaving the higher-viscosity oil behind. It does not evaporate quickly and carbon deposits result. A straight-run oil of not too low volatility will give much better results.

The Use of too Much Oil Causes Carbon Deposits

Another cause of carbon deposits is the use of oil in greater quantities than can evaporate properly in the cylinder. As a result it remains on the cylinder or piston head, and collects in pools wherever there is a depression. Under the combined action of heat and pressure, it soon decomposes and a deposit of carbon results. A volatile oil will have a better chance under such conditions than one of less volatility, but the proper remedy of course is to cut down the oil feed.

Carbon deposits are undesirable for many reasons. If they collect around the piston rings, the rings will stick and, not being flexible, will not maintain the proper seal for the piston. There is leakage of hot compressed air past the piston and the high temperature increases the carbonization of such oil as may reach the rings. The piston and rings, not being properly lubricated, begin to wear; the cylinder sometimes scores, and the general efficiency of the compressor is lowered. When the rings lose their flexibility either from high temperature due to friction, or from being restricted in their action by carbon deposits, the full capacity of the compressor is not delivered and sometimes it is impossible to maintain the desired pressure.

Carbon deposits on the cylinder and pistons may build up to such an extent as to cause knocking from the contact of the piston and the deposit on the cylinder head. This hammering is likely to cause damage to the compressor.

Carbon Deposits on the Discharge Valve

One of the first places where a carbon deposit appears is on the discharge valve. The air drawn into the cylinder through the inlet valve is comparatively cool and serves to keep the inlet valve at a fairly low temperature. The air also carries the oil away from this valve and carbon deposits are seldom found here. As the air passes through the discharge valve, some of the oil is caught on the metal of the valve and valve seat, and they are always found drenched with oil. If the oil remains here long enough, exposed to the temperature of the discharging air, ranging from 200 to 500 deg. F., depending upon the type of compressor, it slowly carbonizes. An oil that evaporates rapidly will form little or no carbon as compared with an oil that evaporates more slowly.

The continued accumulation of carbon on the valve and valve seat prevents proper cooling of the valve and the latter becomes overheated. In addition to crystallizing the metal, drawing its temper, and warping it so that it cannot seat properly, the carbon works between the valve and its seat, preventing tight closing. As soon as the discharge valve fails to close tightly, some of the discharged air rushes back into the cylinder on the suction stroke owing to the lowered pressure. This leakage of hot air raises the temperature of the compressed air above that which would be normally expected, still further increasing the carbonization of the valve and aggravates a condition already bad.

This continued accumulation of carbon and leaky valves lowers the efficiency of the compressor, and it takes more power to compress a given amount of air. Furthermore, the valves may stick open and prevent the operation of the compressor altogether. This means loss of time and money for repairs.

When carbon deposits are caused by an accumulation of liquid oil in a depression in the cylinder or a valve chest, it is a good plan to put a drain with a pet cock into the space and draw off the accumulated oil at intervals before it has had an opportunity to carbonize.

Oxidation of the oil may be another cause of gummy deposits, and on account of their adhesiveness these are particularly undesirable. Oxidation is aided by the concentration of oxygen when the air is compressed. This is evidenced by the difference in the kind of deposits formed in the second and third stages of multistage compressors delivering air at pressures above 1,000 lb. Diesel-engine compressors are susceptible to the same sort of deposits.

All Deposits Are Not Carbon

All deposits found in compressors are not due to carbonization of the oil. Many deposits, when analyzed, show a very large percentage of dust drawn in from the atmosphere and all kinds of metallic substances which could never be secured in any other way. A little oil will bind these materials together in a solid mass which is just as effective as a carbon deposit as far as interfering with the compressor operation.

Summarizing briefly, we may say that a fundamental principle is to use just as little oil as possible. It is better to use a fairly volatile oil than one of low volatility, even though it requires the use of slightly greater amounts. The elimination of the carbon deposits will more than offset the cost of the greater quantity of oil required to maintain the oil film on the cylinder wall.

A straight-run oil is more satisfactory than a blended oil, as it is not so likely to form carbon deposits.

Pure mineral oils of the proper viscosity should always be used. Never use compounded oils, for they will not evaporate without decomposition. Steam-cylinder oils, although sometimes used, are not satisfactory as a whole and should be replaced with a lighter-viscosity oil. Filtered oils are less likely to form deposits than non-filtered oils.

The capacity of the Diesel oil-engine plant together with its location largely determines the type of oil-storage tank. If the plant consumes less than 12,000 gallons per year, two steel tanks of 6,000 gallons each are probably the most advisable size to install. The employment of two tanks provides means whereby a damaged tank can be repaired without a plant shutdown. It allows a thorough cleaning of the tank after each emptying. If steel tanks are installed, they should be set in a pit and covered with two to four inches of concrete.

Common Coal Sense

By V. G. Leach*

There are still many coal buyers who purchase, as coal, anything that is black and can be had at twenty-five to fifty cents a ton less than the prevailing market price. The buyer of this particular class is undoubtedly anxious to save for his firm every cent possible and perhaps create for himself a favorable reputation as being a clever purchaser of fuel.

And then there is another class who buy nothing but the so-called "distressed coal"; that is, cars that some luckless jobber has allowed to come into his district unsold and must get rid of at a sacrifice to prevent the accumulation of demurrage. Unfortunately, however, the mere fact that this coal is "distressed" is often due to its low value as a fuel. Invariably, the chief engineer who has to utilize this coal is almost as much "distressed" as the coal was, and probably entertains some positive ideas regarding his purchasing agent's knowledge of real economy.

Number of Heat Units Not Always Correct Indication of the Value of a Coal

It is generally believed by most coal buyers that the value of a coal is indicated by the number of heat units it contains. Little or no account is taken of the "burning characteristics" or the "stocking or storing qualities" of a coal, when deciding upon the cheapest fuel for any given condition. The heat value is expressed in terms of British thermal units per pound of coal, the determination being made by an instrument called a calorimeter. It should be remembered that this calorimeter determination represents only the theoretical quantity of heat available with 100 per cent boiler, furnace and grate efficiency and does not begin to tell the whole tale regarding the amount of heat that can or will be delivered up to the water in the boiler, the trouble to be anticipated from smoke and clinkers or the amount of furnace repairs that will be required.

An almost universal belief exists, too, that improvements in furnace design or change in furnace equipment is the only road leading to increased economy or capacity. However, it is becoming more apparent of late that one factor of this most important of engineering problems has been almost entirely overlooked, namely the ability of certain high-grade coals to meet new or increased demands for capacity and economy or to eliminate existing objections such as smoke, soot, clinker and high furnace upkeep.

Much money is misspent annually for the providing of new and expensive furnace and boiler equipment; whereas it is possible that only a change in the coal used would have produced the desired results; often merely a change in the size of the coal would have been sufficient.

Drawbacks of the "Specification Method"

In markets where the coal supply is varied and where many coals are camouflaged with trade names that are uncertain and misleading, large buyers are compelled to base their purchases on analysis and heat value. This method, of course, is feasible only where there is the closest co-operation with the engineering department. One of the serious drawbacks to the general adoption of the "specification method" is the difficulty of obtaining, at reasonable costs, samples of coal that are actually representative of the total bulk or quantity of the commercial product delivered.

A great deal of valuable research has been conducted by the Bureau of Mines and the University of Illinois, and numerous bulletins are available on the subject. The purchase of fuel under specifications involves considerable expense both in the sampling and in the analysis. This adds to the price of the coal, and for small consumers renders this method of purchase unprofitable. Also, when the consumer buys directly from an operator whose coal is mined in a certain definite locality and is of a quality known by experience to be satisfactory, the advantage in purchasing under specifications based on the analysis and heat value is not worth the extra expense of sampling and analyzing the coal.

Service Departments Maintained by Many Operators

The most progressive of the operators are maintaining, for the benefit of their trade, service departments composed of one or more experienced combustion engineers. Their services are free of charge, and few indeed are the plants that cannot profit from their advice.

The chief factors governing the value of any coal, under given conditions, are the style of furnace, draft, smoke-producing properties of the coal, and the amounts of ash and sulphur. No definite rule can be laid down to govern these factors. The experience of the engineer in the plant or the advice of a combustion engineer, or both, is perhaps the best guide in determining the best fuel for the particular plant.

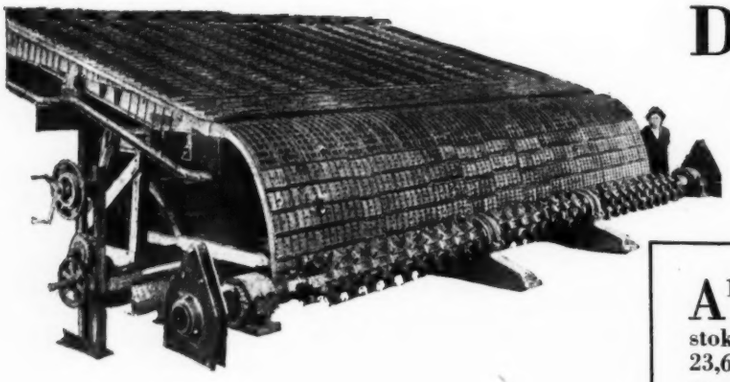
In general it may be said that the higher the moisture, ash and sulphur, the more objectionable the fuel. Another important factor is the fusing temperature of the ash, which, in a way, is indicative of its clinkering propensities. The ability of a coal to resist spontaneous heating in the storage pile is often a factor that demands consideration. Actual boiler tests are sometimes necessary to determine what fuel is the best for a particular plant.

Efforts to Maintain High Standards of Purity

A commendable effort is being made by a few of the high-grade operators to maintain their product at the highest possible standard of purity. The most advanced methods include accurate sampling at the mine of the total tonnage of each day's run. An "ash determination" is then run on this sample, and if the percentage runs unnecessarily high, it indicates that some of the miners are becoming careless and are loading dirty coal. Next day a careful investigation is made and the careless individuals are soon found and eliminated. Without this daily ash determination dirty coal would have been shipped indefinitely, or at least until a storm of protests came in from the consumers.

Packing should be fitted so that it clears the shaft by a very small amount under running conditions. If it is under much pressure and it fits the shaft closely, heating or vibration will occur, together with cutting of the shaft. Carbon packing is usually fitted with a clearance of 0.001 to 0.002 inch per inch of shaft diameter, with the machine fairly cold. Metallic packing does not require so much clearance as carbon, since expansion is much greater under high temperature.

*Combustion Engineer, Bell & Zoller Coal Co.



Detroit Edison Co. Has Superstoker

By E. E. DUBRY
Assistant Superintendent of Central Heating Plants
Detroit Edison Company

A 13-RETORT underfeed stoker having a total grate area of 470 sq.ft. replaces a double stoker setting under a Stirling type W boiler of 23,654 sq.ft. effective heating surface, and makes possible a big reduction in the number of overhead bunkers and coal-conveying equipment.

THE Delray Station of the Detroit Edison Company was one of the first of the large plants to make use of the underfeed stoker. It was here that the Delray setting was developed to accommodate two stokers feeding from opposite sides under a Stirling type "W" boiler having 23,654 sq.ft. of effective heating surface. Both Taylor and Westinghouse stokers have been used in this design for several years, and as usual in all new ventures, numerous minor changes have been made from time to time, until the present designs resemble the original in general arrangement only.

Within the last six months a radical departure in furnace arrangement has been made and is now being tried out. For some time the Detroit company has desired to see what could be done with a long stoker feeding this same furnace from one side only. If this scheme could be made successful, it would reduce the cost of the boiler unit considerably, since with the usual double row of boilers the number of overhead bunkers could be reduced from three to a central one, with a consequent saving in building steel as well as coal-conveying machinery, and with other attendant simplifications.

The Sanford Riley Stoker Co. lately introduced a stoker having long retorts and with other dimensions suitably increased to permit the necessarily high rates of coal feed, calling it their "Superstoker." The unusually long space occupied by the stoker between front wall and ashpit afforded an opportunity to try out the much-desired single-end arrangement of stoker and furnace. Accordingly, the installation was made and the unit put into operation in February, 1922. It has been taking its share of the plant load ever since.

In general design this stoker does not differ materially from the standard Riley type, but the entire mechanism is larger and heavier throughout. There are thirteen retorts, fed by rams 11 in. in diameter having a stroke of 12 in., giving a piston displacement nearly 80 per cent larger than that of the 9-in. ram having a 10-in. stroke, so that with the crankshaft running at a slightly higher speed these thirteen rams feed coal as rapidly as do the twenty-six retorts of the double-ended stoker.

The view shown in the headpiece and the cross-section of the furnace, Fig. 4, on which are indicated the principal dimensions of the stoker, give some conception of the bigness of this machine.

In addition to certain special developments to adapt the design to such comparatively large proportions, there are incorporated the usual features, including the

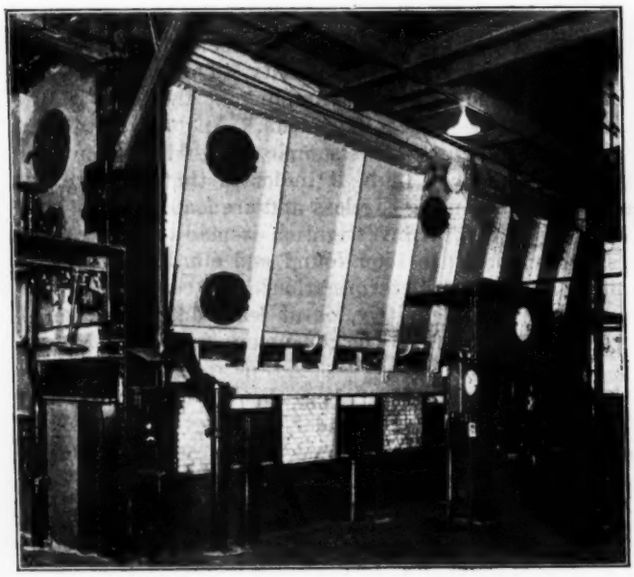


FIG. 1—GRINDER END OF UNIT, SHOWING HELICAL SPRINGS ON THE APRON CONTROL, ALSO INSTRUMENT AND CONTROL BOARD

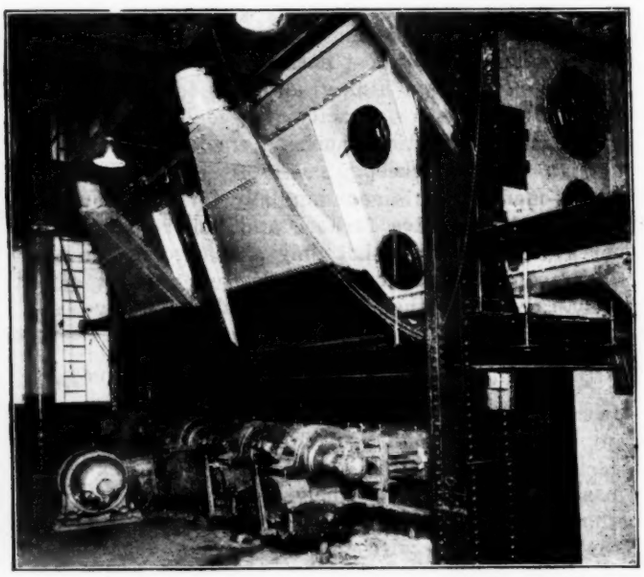


FIG. 2—FRONT VIEW OF UNIT; STOKER IS DRIVEN BY 25-HP. MOTOR AND FITTED WITH FIVE TWO-SPEED POWER BOXES

FIG. 3—REAR VIEW OF STOKER ASSEMBLY AND FURNACE

moving side bars and tuyeres, moving aprons forming one side of the clinker pit, two-speed power boxes, flaring retort sides to assist feeding coal along the retort, cylinders fitted with sifting rings and renewable liners. All other parts that are subjected to either erosion or corrosion are easily replaced. The clinker grinder is made up of cast-iron sections bolted to a shaft of extra-heavy 8-in. pipe. This shaft has a section modulus in torsion equal to that of a 6-in. square solid shaft. The grinder shaft is divided into two parts each one-half the width of the stoker, with separate motors and controls. It revolves away from the stoker against adjustable aprons mounted on the back wall or bridge wall of the furnace. These are fitted with helical springs, making it possible to discharge an extra hard clinker without breaking any of the mechanism. The total weight of the stoker is 65 tons.

Fig. 1 shows the grinder end of the unit with the helical springs on the apron control. The grinder motor control is located on the building columns, while other controls and instruments are on the gage board as shown.

The extreme end of the stoker proper consists of moving sections extending down toward the grinder and forming one wall of the clinker pit, opposite the bridge wall aprons just described. Adjustment of the gap between the grinder and these moving sections can be made from the firing floor through a rack and pinion. Large ash gates operated by an air cylinder allow the ashes to fall directly into steel cars drawn by electric locomotives.

A single motor-driven fan discharges air into a roomy air chamber with dampers for controlling its distribution. Further changes will be made in the control zones in order to obtain better control of the air distribution.

The outstanding feature of this particular type of stoker is that the tuyeres or grate blocks are movable in a direction parallel to the path of the coal. The length of travel is adjustable and under control of the operator, but the period of oscillation is dependent upon the stoker speed, since each complete tuyere box, from the point where coal enters to the end of the apron at the grinder, is driven by its corresponding ram.

Considerable difficulty was experienced at first with the burning out of the tuyeres. Several changes were made, and finally there was developed a tuyere, as shown in Fig. 5, which seems to be satisfactory.

The stoker is divided into five sections, three of which have three retorts each and two have two retorts, the latter being the two outside sections. Each section has two gear ratios and a neutral point which are easily obtained from a lever located at each power box (see Fig. 2).

A single 25-hp. direct-current motor with a speed range of 400 to 1,600 r.p.m. drives all the stoker mechanism except the clinker grinder. It drives the main power shaft through a

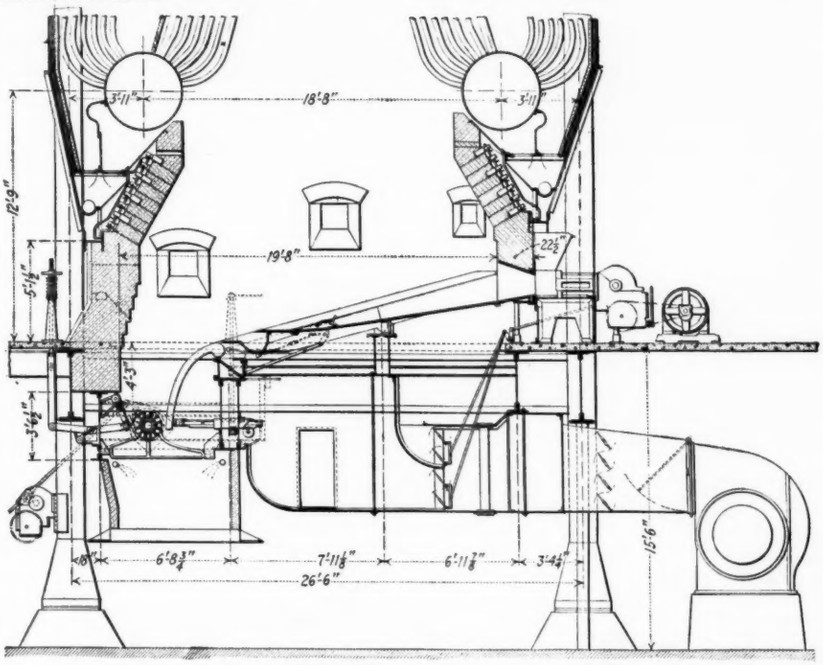


FIG. 4—CROSS-SECTION OF FURNACE AND STOKER

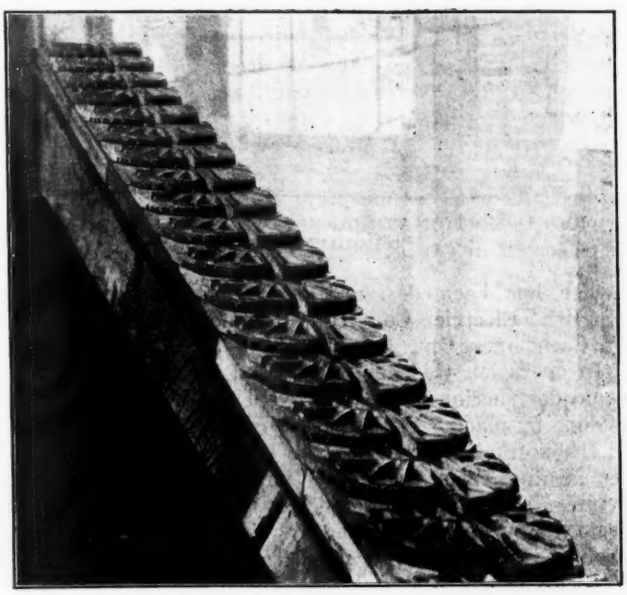


FIG. 5—SHOWS ASSEMBLY OF SIDE BARS AND TUYERE BLOCKS

single-link belt; the connection between this mainshaft and each section is made inside the power boxes, leaving the link belt and the mainshaft the only moving parts exposed except, of course, the main stoker crankshaft and tuyere-box adjusting levers.

Because of the size of such a unit a complete test involves the serious disturbance of normal plant operation, and for this reason has not been possible so far this year. Various preliminary observations which have been made, however, lead to the belief that the work of the two sides of the boiler is quite evenly distributed since the gas temperature at the beginning and end of each half are practically the same, likewise the temperatures of the steam leaving each superheater. The stoker responds quickly to an increase in the rate of combustion and can pick up load as rapidly as the double-ended units.

Governing Device for Hydraulic Impulse Turbines

When a large high-head hydraulic turbine is operating under near full load and this load is suddenly dropped, if the governor functions quickly enough to maintain the speed within reasonable limits, a large rise in pressure results in the penstock. It is to prevent this rise in pressure in the penstock serving impulse-type waterwheels, that the Seewer governing

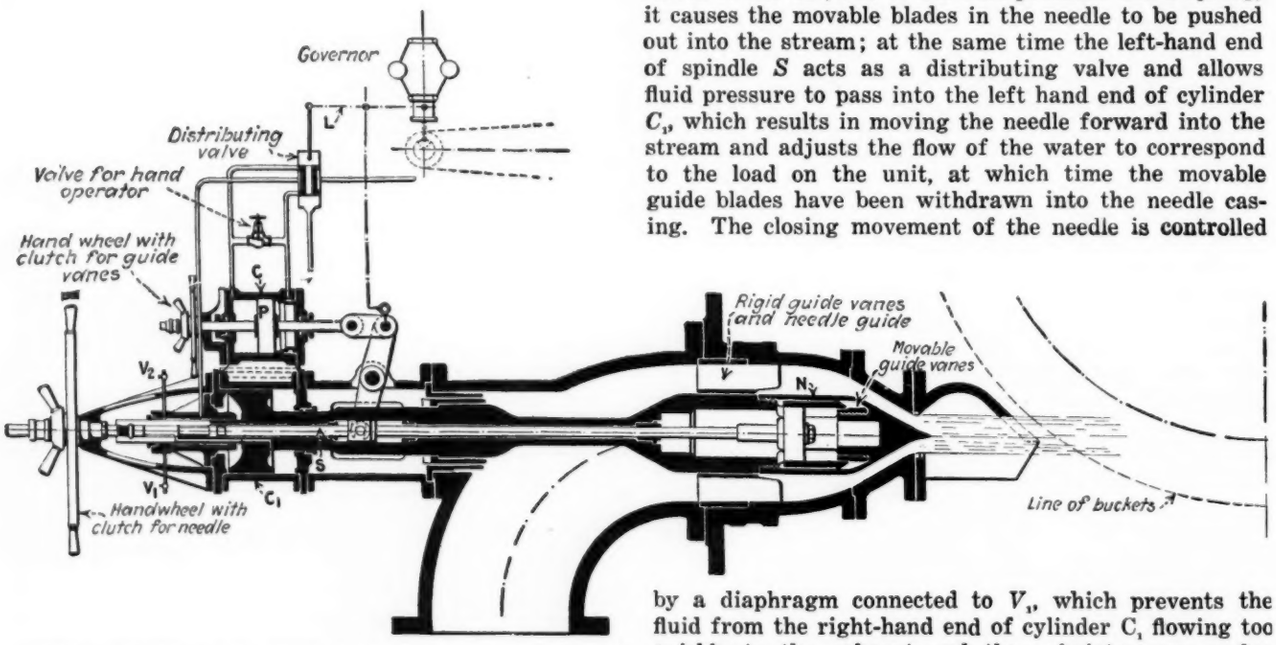


FIG. 1—SECTION THROUGH NOZZLE AND CONTROL EQUIPMENT

device has been designed and manufactured by the English Electric Co., Ltd., London, England, and St. Catherines, Ont., Canada.

In operation this device is based on the principle of rapid destruction of the energy of the water jet, which is done by placing blades in the nozzle at a slight angle to the normal direction of the stream flow so that the jet issuing from the nozzle will be changed from a cylinder shape to a hollow cone, thus diverting the jet from the buckets. The blades are shown in the advance position in Fig. 2, but normally they are withdrawn into the needle casing. The blades are carried by a movable ring, which is connected to the governor by a rod passing through the spindle of the needle. When a sudden drop in load occurs and the speed rises, the blades are pushed forward into the stream, giving it a whirling movement which makes it lose its useful energy.

The operation of this device will be understood by referring to Fig. 1. With a sudden drop in load and speed rises and causes the governor to operate and raise the right-hand end of lever *L*, which will result in the left-hand end pushing down the distributing valve

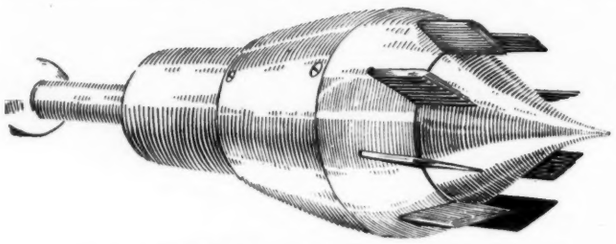


FIG. 2—NOZZLE NEEDLE SHOWING BLADES IN ADVANCE POSITION

and opening the port to admit the governor fluid to be admitted into the right-hand end of cylinder *C*. The piston *P* in this cylinder connects to the movable guide blades in the needle casing *N*. As the piston moves to the left, due to the fluid pressure and a spring, it causes the movable blades in the needle to be pushed out into the stream; at the same time the left-hand end of spindle *S* acts as a distributing valve and allows fluid pressure to pass into the left hand end of cylinder C_1, which results in moving the needle forward into the stream and adjusts the flow of the water to correspond to the load on the unit, at which time the movable guide blades have been withdrawn into the needle casing. The closing movement of the needle is controlled by a diaphragm connected to V_1, which prevents the fluid from the right-hand end of cylinder C_1 flowing too quickly to the exhaust and thus obviates any undue pressure rise in the pipe line. For an increase in load the reverse takes place, and in this case the diaphragm that connects to pipe V_2 controls the speed with which the needle is withdrawn and the normal operation of the jet is resumed.

During the calendar year 1920, 1,141 electric light and power companies paid federal income taxes to the amount of $5,429,643. Figures just made public by the Bureau of Internal Revenue show that these companies reported net incomes aggregating $48,777,438. In all, 1,687 companies made returns. However, 546 electric light and power companies had no net income, but, instead, reported deficits totaling $2,366,832.

EDITORIALS

Suggestions for Improving Design and Operation of the Small Plant

IT PAYS to improve the power plant and increase the efficiency up to a certain limit. Privately owned plants are small in comparison to large central stations, being often one-tenth to one-hundredth of such capacities, so that commercial and engineering considerations do not warrant as elaborate an equipment.

Much can be gained, however, by noting the refinements and improvements in large stations since it pays in the latter case to investigate and develop to an extent prohibitive in a smaller installation, and yet the results obtained may sometimes be adapted directly or modified to suit privately owned plants.

The article appearing in this issue of *Power* on "Steam Turbine Operation," being an abstract of a paper read at the recent meeting of the Institute of Iron and Steel Electrical Engineers, describes interesting methods and devices of the Duquesne Light Company, the Colfax Plant of which contain two units of seventy thousand kilowatts each.

Instruments to determine the mechanical condition of the apparatus, the arrangement of equipment to permit of a small operating force, the management of the lubricating system and other points may be utilized in some form at a reasonable expenditure, with decreased cost of maintenance in many smaller installations.

Service to Buyers of Power Plant Equipment

IN RECENT years there has been a considerable growth, and on the whole a healthy growth, in the service activities of manufacturers. Reference is made particularly to periodic inspections of equipment after it is sold, to see that it is operating properly and also to detect and remedy anything that might lead to future trouble.

Of course, such a service is not to be recommended in every case. There are certain types of equipment that have been used for so many years, and are so well understood by operating men, that no help is needed from the manufacturers. But there are others, more recently placed on the market or too specialized to be fully understood by the average engineer, that require such a service for the best interests of the manufacturer as well as the customer.

It has been said many times, but will bear repetition, that the purchaser does not pay his money for a certain piece of equipment, but for certain results he wishes to obtain. If he, for any reason whatsoever, does not operate the appliance to the best advantage, he is more or less dissatisfied and the manufacturer loses that much good will. Unfortunately, this is true even where the manufacturer supplies a first-class article at a fair price. This is so obvious that it seems like saying that two and two make four. Yet there is a natural tendency for the manufacturer to feel that nothing remains to be done if a good machine has been delivered in good order, and the invoice has been paid. On the other hand, it will not do to overlook the cases where it is not practicable to render a service of the kind described, even though it would be of decided benefit to the customer. Such a condition might occur where the appliance is low in price and sold only to occasional power plants. In such a case an intensive campaign might increase distribution to a point where an inspection service would be economically possible. If this is not possible, it is essential that the instruction booklets and other literature supplied to the customer be of the highest grade; that is, they must contain a maximum of practical information in a form that will insure their being read and understood.

Possibilities of the Automatic Hydro-Electric Plant

AUTOMATIC control of electrical equipment has been developed to such perfection that it is no longer a question, Can this or that operation be made automatic, but Where shall automatic control be applied? Less than ten years ago the first automatic rotary converter substation was put in operation, and since that time these stations have been applied to practically every class of service, from supplying power to railway loads in outlying districts to serving densely populated sections over three-wire Edison systems. These stations have been applied not only to loads supplied from central stations, but also to industrial loads.

Five years ago, when the first automatic hydro-electric plant was put into service, it created no small amount of interest in engineering circles. Since that time these installations have increased in number, until they are to be found in practically every part of the country where water-power developments are made, and they have increased in size until recently a 5,000-kilowatt plant was put in operation, and a 10,000-kilowatt station is under consideration, as pointed out by F. R. Culp, in the leading article in this issue. When first put in use, it was thought that this class of station was applicable only to small plants in remote districts where it was difficult and expensive to maintain an operating force, but present developments have indicated other possibilities than these.

There has been much discussion on the elimination of the human element in the operation of the plant by the application of automatic control. The troublesome operator, as he is frequently called, is probably not entirely responsible for all the evils laid at his door. The fact of the matter is that those to whom the operators are accountable are at fault for not giving more careful attention to their training. Where operators have been intelligently selected and carefully trained, it has been found that mistakes in routine operation have been practically eliminated, and that the operators can be depended upon to do the proper thing in emergencies. Reliability of electric service is becoming more and more necessary and the question of maintaining costs at a normal figure more difficult. Anything that will improve the reliability of the service and keep down the

cost will undoubtedly receive consideration in the future. Whether the best solution is better-trained operators or a greater application of automatic control to hydro-electric stations, or a proper combination of the two, sufficient evidence is not at hand to make the decision.

There seems to be little reason for making the large-sized plants automatic, since the cost of manual control is so small relatively, as to make it inadvisable to go to the expense of installing automatic equipment. In such plants considerable switching from one set of machine busbars or feeders to another is generally necessary, and although this probably could be done automatically, the complications are not warranted. Furthermore, if anything happened in such plants to cut them off the system, it would be necessary to have someone in them to restore the service in the least possible time, and this can be done only by having responsible operators in the plant. In the small and medium-sized plants there are in general no such restrictions as in the large station. These plants frequently operate as parts of a large system, which can carry the total load if the former are disconnected. In developing small water-power sites, elimination of the operating force at such plants may be the deciding factor in making the development possible, especially in remote districts, and it is in such places that the automatic plant will probably continue to find its greatest application.

Why So Much Noise?

MUCH is said and done regarding training, safety, comfort and morale of the operating force, yet in entering many large power stations, one is struck, in both a figurative and physical sense, by the magnitude and penetration of the noises within, due to the generator air being discharged directly into the room.

Large turbo-generators are built for forced ventilation, and opening the machine to the room sometimes lowers the temperature a trifle more than would be obtained with a duct to the outer air. This may mean more capacity in emergencies, or perhaps the price of the discharge duct is not deemed equal to the cost of wear and tear on human beings resulting from the increase in noise. Closed air circulating systems, such as are used in Europe, may come into favor more generally here for reasons of preventing generator fire when an electrical breakdown occurs.

Protecting the operator from excessive noise as well as heat and floor vibration, would bear more serious consideration than appears to be the rule at present.

Public Service Claims Another Engineer

FOR years, it is frankly admitted by the Post-Office Department, the choice and maintenance of the labor-saving machinery used in post-office work has been left to men with no technical training whatever. More and more rapid has been the growth of the postal business and greater and greater has become the consequent need for equipment designed to save time and money; yet only today, apparently, has it dawned on the Postmaster-General that a mechanical engineer would be a handy chap to have around.

What could be more obvious than that the selection and care of machinery of any sort should be entrusted to no one but a man properly trained for such work? And what more encouraging than the tendency on the part of the layman (personified in this case by the Post-Office Department) to recognize at last the engineer's real value to the community?

The Post-Office Department has seen fit to create a new position, that of chief engineer, and has chosen to fill that position a man with a splendid record.

The engineer has a definite place in public life—the success of those already engaged in public service bears witness to that fact—but so far the surface has been only scratched. There are hundreds of other positions in the federal, state and municipal governments for which the "engineering type of mind" is best fitted, and these positions the engineer must eventually fill, if his profession is to be brought to true parity with that older and longer recognized profession, the law.

Standardizing Motor Controller Parts

ELECTRIC controllers have been designed in almost an unlimited number of forms, but little effort has been made toward the standardization of this equipment or its parts. There is much development work being done at present in improving the characteristics of controllers for electric motors, and this will undoubtedly continue. However, there are certain parts, such as resistors, that could be standardized to good advantage not only for the user, but also for the manufacturer. Standardization should not be carried to a point where it will interfere with the progress of an art. On the other hand, the manufacturing should not be done in such a way as to place an undue burden upon the industries utilizing the equipment.

There are hundreds of different types of resistance boxes in use for service, where one-tenth the number or less could meet all requirements. These are devices that have become practically standard, therefore adopting standard shapes and sizes will in no way interfere with improvement in control design. If the manufacturers and users will get together and decide upon the necessary forms and sizes to meet the needs of the industry, much unnecessary cost and confusion will be eliminated and a real start will be made toward standardizing control equipment parts.

Engineering or Nostrums—Which?

WE ARE in for a bumper crop of nostrums this winter. They never fail us when coal or anything else runs a little short. Crooks, quacks and the well-meaning numskulls will vie with each other for the privilege of "serving" the great public. It is too bad, particularly so because along with the nostrums the public will receive suggestions of real value and be offered devices of genuine usefulness.

In general, the power-plant engineer will be able to distinguish the real remedy from the false one, but the public will fall hard as usual. There will be a tremendous sale for gas burners that "consume air instead of gas" and for those that extract more heat than the gas contains. Hard-earned dollars will be spent for mysterious powders and fluids to sprinkle on the coal.

Federal and State Fuel Administrations can render a real service to the people by issuing a general warning regarding the more common types of combustion fakes, and by dealing with others specifically as they arise. It goes almost without saying that all publicity of this sort should be based upon the findings of responsible combustion engineers and fuel experts.

PRACTICAL IDEAS from PRACTICAL MEN

Preventing Delays When the Elevator Overtravels Limit Switch

In observing the operation of a number of elevators over a period of years, it was found that about 90 per cent of all delays in elevator operation were caused by the car traveling below the ground-floor limit switch. This opened the main magnet or "potential" switch, which made it necessary either to call an electrician from the shop or to find someone to climb to the elevator pent house and hold in the main switch until the operator could run the car clear of the limit switch. Such delays reflect on the capabilities of the men responsible for elevator maintenance, and even the most careful operator will sometimes allow the car to overtravel the limit switch. Overtravel may occur from many causes, such as heavy loads, too high operating speed, loose brakes and carelessness or inattention on the part of the operator.

In order to eliminate as far as possible the inconvenient delays resulting from overtravel, the writer installed a short-circuiting switch on the elevator car, together with a two-conductor No. 16 flexible cable, which was suspended under the car with the control cables and at the stationary junction box on the side of the elevator shaft. This cable connected to a No. 14 two-conductor armored cable which led down to the limit switch at the ground floor, one conductor being fastened to the stationary contact and the other to the moving contact of the switch. The switch used for short-circuiting purposes was a stop-button station with contacts arranged for normal position open. The cast-iron box of this switch was bolted to the side of the elevator cage about even with the controller, and a section of ½-in. conduit was screwed into the switch box and extended down through the floor of the elevator car. This arrangement does not interfere with the proper operation of the limit switch, and there remains two additional limit switches which are not affected by the operation of this short-circuiting switch across the first limit switch, and neither is the automatic contact switch on top of the car affected. Consequently, there is no possibility of any trouble on this extra circuit affecting the safety of operation of the elevator.

Three years' operating experience with this device on a high-speed passenger elevator has shown it to be free from trouble, and it has eliminated about 80 per cent of the delays previously experienced on this elevator.

Where regular weekly inspection of the elevator controls and mechanism is made, practically all delays can be avoided. In this particular instance the line voltage was subject to considerable fluctuation, and occasionally the governor would trip out from overspeed due to excessive voltage, and this condition contributed practically the only delays experienced in the last three years.

The cost of material for this installation was about $15 and the cost of labor about $15, making a total expense of $30. The installation was made in three Saturday afternoons, at which time the elevator could be taken out of service without material inconvenience.

Kansas City, Mo. J. E. HOUSLEY, Elec. Eng.,
Aluminum Company of America.

Selling Cold Storage

Some time ago it became necessary to learn the usual price made by refrigerating companies for cold storage when the brine is pumped to the consumers' ice box or cold-storage room. One large cold-storage company answered quite fully, and with the idea that the information thus secured may assist others confronted by a similar situation, the main portion of the data is submitted as follows:

At the present time there is no practical meter for refrigeration in small and medium-sized services, so that our prices are made by the superintendent of our street department and are based upon the square feet of pipe surface installed, the wall surface, the approximate amount of goods handled, the coil surface and the number of times the refrigerator must be opened and closed, and lastly, upon the temperature required. Any one or a combination of these give him a basis for figuring the approximate tonnage required, and of course, he has to estimate the maximum conditions rather than otherwise.

For small services where overhead charges for the connection and the cost of inspection would be quite a percentage of the income, the price is approximately $4 per ton of refrigeration delivered.

On medium-sized boxes, taking up to from three to five tons daily, the charge is based approximately upon a rate of $3 a ton; for customers taking ten to twenty-five tons the rate is $2.50; customers taking fifty tons receive a rate of $2.25 and anything over fifty tons, $2 a ton.

As a matter of fact we have two or three large customers having a day demand as high as one hundred tons who have a special discount due to the fact that they are in our own buildings, which results in a net price of approximately $1.80 a ton.

These prices are for brine at 10 deg. F., which is the

temperature of brine delivered to our street system. We have customers on our low-temperature line, which is 10 deg. below zero, for which the charge is from 15 to 25 per cent more, depending on local conditions. These local conditions are such details as the cost and difficulty of tapping into our circuits, insulation, etc.

While the estimate would be somewhat the same as electrical service, the cost of making flow and return connections to our mains with insulation and all that goes with it, makes the cost of connecting the service much greater than with electricity, and the only way which we have found this equitable, is to make it a part of the charge to the customer in so far as it is reasonable from a business viewpoint.

We are metering our large services by using venturi meters and recording thermometers showing the difference in temperature of the brine in and out. This gives us the B.t.u. and consequently the tonnage.

Some day we expect to have a practical refrigerating meter, and then we can probably have a reasonably standard basis for price with a sliding scale after the manner of charging by the gas and electric companies.

New York City. G. GROW.

A Convenient Form of Lazy-Bar

Removing ashes from inclined ashpits, such as generally found under hand stokers, is usually done with a long-handled shovel and the aid of a bar (called a lazy-bar) put across the door to take the weight when drawing out the shovel.

To make this job somewhat easier we have recently put into use in our plant an improved type of lazy-bar,

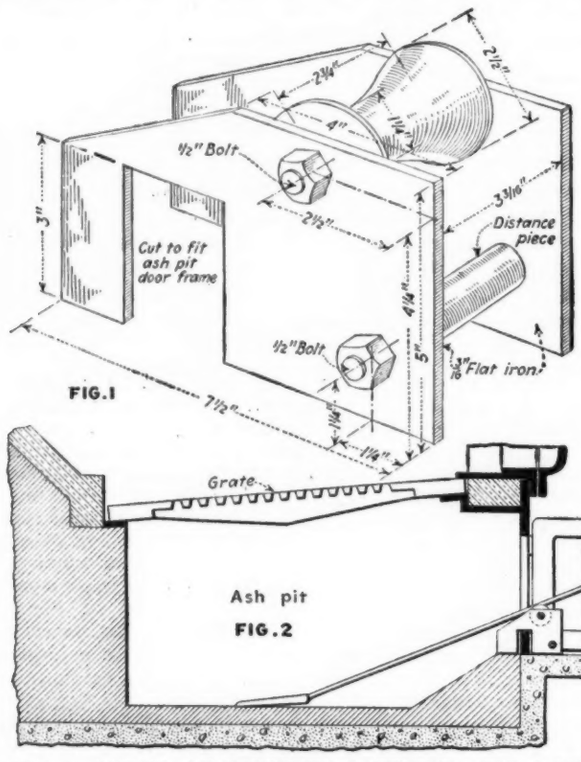


FIG. 1—DETAIL OF IMPROVED LAZY-BAR. FIG. 2 SHOWS BAR IN POSITION

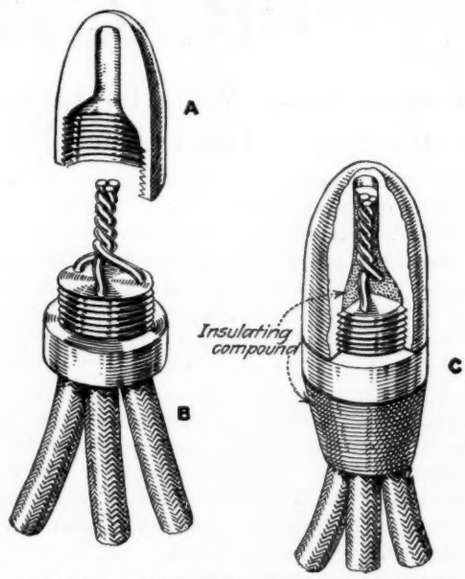
the general design and dimensions of which are shown in Fig. 1. The frame is made of ⅛-in. flat iron, and the slot is cut to fit over the lower part of the ashpit door frame.

The spool has ball bearings and was reclaimed from a carrier used for feeding a condenser-tube cleaner, but a discarded bicycle cone or a spool with a machined bolt for a bearing will answer the purpose quite as well. The shovel we use is a No. 14 sawdust scoop fitted to 1¼-in. tubing 11 ft. long over all. Fig. 2 shows the lazy-bar in position. W. C. E. WOLGAST.

Elmira, N. Y.

An Improved Wire-Splicing Device

A wire-splicing device somewhat similar to that described on page 945, in the June 13 issue, has been put on the market in Germany and Holland. The bare ends of the wires are pushed through the holes made in the porcelain disk *B* and then twisted together. Soldering can be done with a small soldering lamp or soldering



PARTS AND ASSEMBLY OF SPLICING DEVICE

iron. Insulating compound is then applied to cover the joint, which is finished by screwing the porcelain insulating shell *A* to the disk *B*, as shown at *C*, and insulating compound is put around the base of the porcelain, to complete the job. H. WEILAND LOS.

Schoonhoven, Holland.

Experiences with a Diesel Engine

While operating a 225-hp. Diesel, we were bothered by a sharp pound in No. 1 cylinder. Thinking the air bottle that was floating on the air line might be full of water, I drained it, but this did no good. Knowing that all the engine valves were set properly and tight and so could not be the cause of the trouble, the drip cock on the air compressor between second and third stage was opened, as a matter of experiment, and the moisture trapped in the compressor intercooler drained out. Immediately the pound disappeared. No. 1 cylinder was the first to take air off the line, and instead of the moisture in the air dropping into the working bottle, it was carried by and went into No. 1 cylinder. It was found that with the drip left open to drain the water no pound was heard.

A great many operators fail to set the several engine valves for the proper opening and closing timing. If they will follow the instructions for finding piston dead centers as given in the Question and Answer columns of *Power*, Aug. 8, 1922, and then mark the timing of the

valves on the wheel rim so that the settings may be checked, they will save a lot of work and trouble. Some engineers set only the fuel valves by measurement, and for the other valves they merely give clearance between the valve stem and push rod. Engineers should not wait until valves leak badly before regrinding, but should examine them regularly. In this way the engine will give better results.

We were breaking exhaust-valve springs regularly. The boss was trying to save a few cents by buying them from firms that sold them cheaper than the engine builders. He is now convinced that it did not pay, and the same thing applies to all parts of engines and compressors.

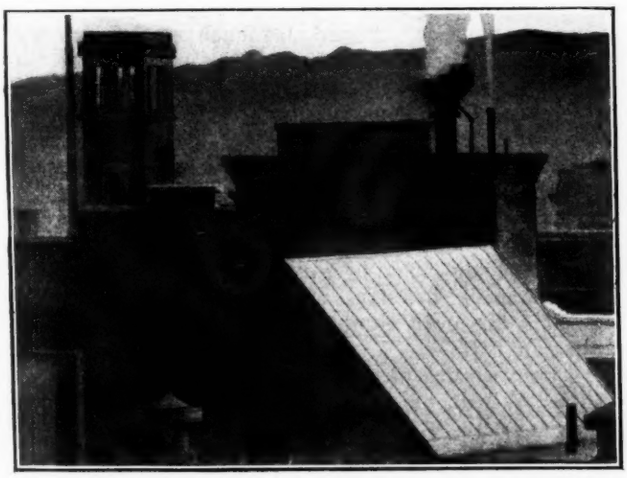
CHARLES QUINCY.

Cleveland, Ohio.

Sulphur Attacks Exhaust Head

The illustration shows the deterioration that has taken place on an exhaust head located above the roof of a building occupied by a publishing company. Oil is used for fuel under the boilers, and the placing of the exhaust head so close beside and above the stack has been one of the causes of its destruction.

The sulphur content in the escaping flue gases, mixing with the moisture in the exhaust steam, combines to



CORROSION OF EXHAUST HEAD CAUSED BY SULPHUR CONTENT IN CHIMNEY GASES

form sulphurous acid and has attacked the head as shown.

In the immediate vicinity are several exhaust heads, many of them having been in service for a considerably longer time than the one here shown, that are still in good condition, but they are out of the reach of the sulphurous fumes.

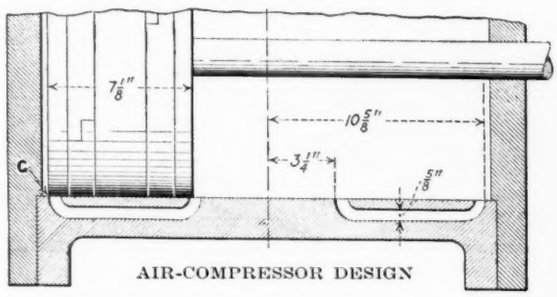
H. R. LOW.

Providence, R. I.

A Peculiar Design of Air Compressor

While a two-stage compressor was being overhauled, a set of passages was found in the cylinder walls. In the high-pressure cylinder there was one passage at each end, while in the low there were two at each end. The sketch illustrates the passages in the low-pressure cylinder wall, which had also a water jacket, not shown. With the clearance equalized, the piston at the end of the stroke would come to rest between the ends of the passages, with an opening of about $\frac{1}{16}$-in. at point *C*.

While there may be some advantage that I could not see, there is one very apparent disadvantage. This is the large amount of air that would flow from the compression side of the piston to the suction side, causing



AIR-COMPRESSOR DESIGN

a decided loss in efficiency. Not seeing any advantage in that, I plugged the passages. Perhaps some reader of *Power* can guess what they were for and if they are of advantage.

R. MCLAREN.

Toronto, Can.

Oiling System for Small Engines

In a plant where there are ten 150-hp. vertical engines in operation, it formerly required two men on each shift to attend to the oiling of these units. Recently, an oiling system has been installed on each engine, the number of oilers has been reduced to one and a big saving in oil has been made.

The receiving tank is first filled with oil, and it flows by gravity to a filter located below the receiver. Then it is pumped from the filter to the regular oil cups on

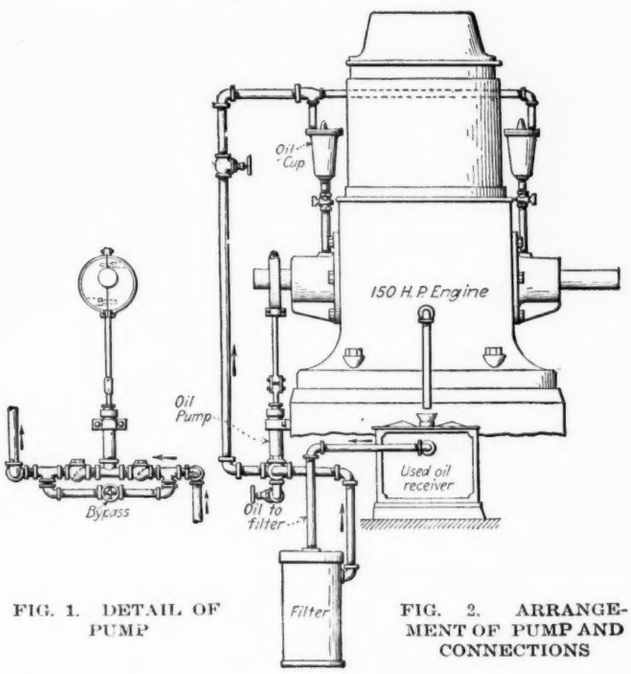


FIG. 1. DETAIL OF PUMP

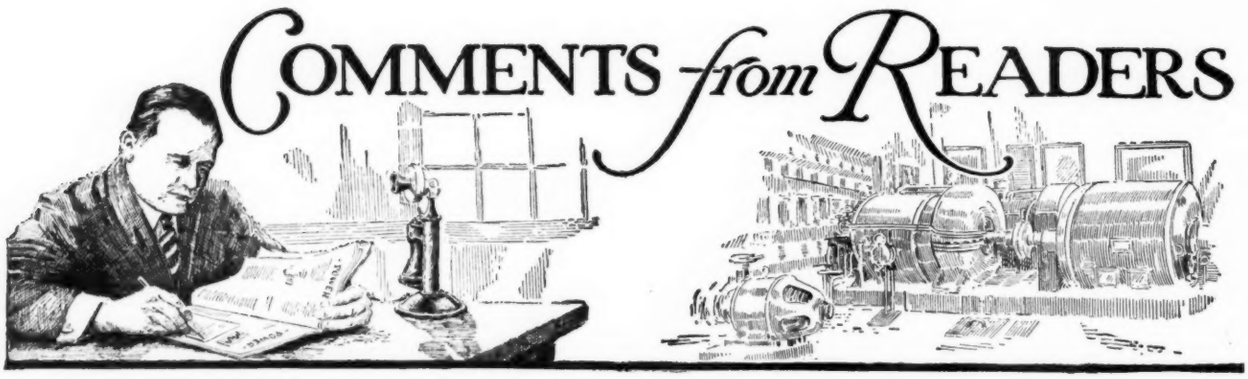
FIG. 2. ARRANGEMENT OF PUMP AND CONNECTIONS

the bearings by a small plunger pump operated by an eccentric on the mainshaft of the engine.

The pump is made from a piece of $\frac{1}{2}$-in. diameter brass tubing threaded at both ends. One end of the tube is screwed into a cap fitted with a stuffing box, and the other end is screwed into a tee which forms the base of the pump. Check valves are fitted on each side of the tee and also bypass connections, as shown.

Fall River, Mass.

ARTHUR D. PALMER.



An Examination Question

I fully agree with the comments made by Mr. Christopher in the Sept. 5 issue with regard to questions usually asked on examinations. Why examiners (either stationary or marine) ask the questions they do is beyond my comprehension. What has the engineer who operates with a license got to say about how the joints in boilers shall be made? I consider this as a part of the designer's work. When an engineer assumes charge of a plant, he certainly cannot have the boilers changed. It is, however, well for him to know the necessary points about safety valves. The general run of licensed engineers (marine or stationary) are there to operate the plants and, therefore, the best is expected of them regarding economy as well as safety. In my opinion if the examiners were to question the candidates for license along really practical operating and economical lines, they would do some real good.

Too often engineers are allowed to have charge of and operate plants containing electrical and refrigerating machinery where they are inexperienced. But they get by on account of their knowledge of the boiler, this being the only thing on which they were examined. In my opinion they should be required to show what they know about each and every machine in the plant they are to operate.

R. G. SUMMERS.

Rochester, N. Y.

Temperature a Reliable Measure of Vacuum

The question asked by W. W. B. in the Sept. 12 issue and the answer given infer that the temperature of steam is not a reliable measure of vacuum because of the presence of air.

Literally speaking, they are both correct, but when used in a practical way in connection with modern condensers, I believe the inference is misleading, as will be shown by an example. Good condenser practice today permits a maximum of one cubic foot of air leakage per minute for each 8,000 sq.ft. of surface.

A condenser large enough to serve a 15,000-kw. turbine would have about 25.000 sq.ft. of surface and would operate with an air leakage of about 3 cu.ft. per min. This same turbine, when operating at an average load, will require 160,000 lb. of steam per hour.

At a pressure of 2 in. of mercury absolute (which is equivalent to a 28-in. vacuum, referred to 30 in.) steam occupies 340 cu.ft. per pound. The total volume of steam discharged to the condenser, after subtracting for that condensed on account of having its heat converted into mechanical energy, would be approximately 340 × 150,000 lb., or 51,000,000 cu.ft. per hour or 850,000 cu.ft. per minute.

Three cubic feet of air at atmospheric pressure is equivalent to about 45 cu.ft. at 2 in. absolute. The mixture will then contain 45 cu.ft. of air and 850,000 cu.ft. of steam. When mixed together, the separate pressures produced by each vapor are proportional to the quantities and the increase in pressure due to adding 45 cu.ft. of air to 850,000 cu.ft. of steam at 2 in. absolute pressure, will be approximately 0.000106 in., or only 0.005 of one per cent, which is negligible. It will be recognized that this pressure is much less than the error usually made when reading any ordinary mercury vacuum column and also much smaller than the error caused by the variation in temperature of the mercury, or by the depression in the glass tube due to the capillary repulsion between glass and mercury, or to the difference in the apparent specific gravity of mercury at elevations other than at sea level and at different latitudes.

No mention has been made of changes in the barometer because this is a fundamental correction that must be and is usually made by everyone. However, I think it is extremely doubtful whether the errors in the barometer are ever eliminated by the use of careful calibration data.

The temperature method of determining pressure is more accurate in most cases because it is more fundamental. There are, however, certain common-sense requirements that should be complied with, one of which is that the thermometer be so installed that the temperature of the steam be determined rather than the temperature of the pipe. Thermometer wells having fins or radiating disks will assist in the heat transmission from the steam to the bulb of the thermometer. Another requirement is that the thermometer be located in the path of the steam so that the average quality of the mixture will pass it. In other words, it should not be located in a dead-air pocket.

The use of thermometers for indicating condenser performance has given satisfactory results to the writer for more than eleven years.

In the beginning special thermometers were built which had two scales, one a temperature, the other a vacuum. Later, the use of the vacuum scale was abandoned and all new thermometers were purchased with single scale graduated in degrees F. Partial scale graduations with a range between 60 and 120 deg. F. were found advantageous because the divisions were large and easy to read accurately. An expansion chamber at the top of the thermometer stem large enough to accommodate the mercury in case the temperature reached 220 deg. F. was provided in order to protect

the instrument in the event that the condenser should "lose its vacuum."

Since most other condenser readings are expressed in degrees and since thermodynamic efficiency is measured by the temperature differences, it seems worth while to eliminate the odd unit (inch of vacuum) and simplify the analysis of condenser performance by the use of something that is more fundamental than mercury columns and requires no barometer or other changing corrections. J. C. HOBBS.

Pittsburgh, Pa.

Location of Purge Valve in a Refrigerating Plant

Relative to R. G. Summers' question as to where the purge valves on a refrigerating plant should be placed, I will say that the cut shown in *Power*, Sept. 5, 1922, by Mr. Summers, is correct. The purge valve should be placed at the highest point of the condensers because foul gases are not so easily condensed as ammonia, therefore the ammonia condenses and the foul gases remain in a gaseous condition and can be easily and readily drawn off. D. BRIDGES.

Hugo, Okla.

Insulation of Furnace Walls

In the Aug. 8 number of *Power*, under the title, "The Insulation of Furnace Walls," H. T. Matthew illustrates the possibility of reaching wrong conclusions from correct premises—or rather, from data that are correct but insufficient. In this discussion of the heat loss from boiler walls he uses the *conductivity* constants only, of various kinds of brick in arriving at the heat emission. As a matter of fact the heat *conductivity* of materials is not the sole consideration of heat transfer, and it may be of little or no value to the operating engineer.

It has been determined by tests that the temperature drop through metal walls separating regions of high and low temperature, is negligible as compared with the total drop. The fall of temperature in passing through the surfaces, or surface films, of the wall is so great as to make the drop through the wall itself appear trifling. Were it otherwise, and the temperature drop were only that caused by the resistance to conduction, then steam boilers for one thing would be but a small fraction of their present sizes, because the heat transfer from hot gases to water would be enormously increased.

Because of the involved nature of the problem there is a tendency to ascribe exaggerated losses by radiation to furnaces of various kinds. Often one may avoid serious error by comparing the probable furnace loss with some heat-transfer apparatus of known emissivity, and basing one's judgments thereon.

Had Mr. Matthew considered the probable effect on efficiency of the boiler in the example, whose setting emitted 622 B.t.u. per sq.ft. per hour, it might have given him pause. This setting was emitting $850 \times 622 = 528{,}700$ B.t.u. per hour.

In pondering on the heat emissivity of various apparatus, it is well to ask: Can the hand be held on the surface? Can the surface be touched with the tips of the fingers without blistering? Everyone knows what to expect when placing the hand on a steam radiator—the radiator giving off 250 B.t.u. per hour per square foot. What could be expected of the boiler wall giving off 622 B.t.u.? I think (as boys would express it) that spit would "sizzle" on it.

When one considers that the heat emissivity of bare steam lines (in ordinary power-plant practice), of ¼-in. metal of high conductivity, is generally accepted as 3 B.t.u. per sq.ft. per degree temperature difference per hour, figures of 5 B.t.u. and 6 B.t.u. (from the chart accompanying Mr. Matthew's article) for red brick and firebrick one inch thick, should suggest error.

Kansas City, Mo. C. O. SANDSTROM.

[It should be noted that the second paragraph of the foregoing letter refers specifically to metal walls, where the internal temperature drop is ordinarily very small in comparison with the surface drop. In the case of thick brick walls the condition is reversed, the temperature drop within the wall being ordinarily greater than the surface drop. Referring to the last paragraph, it should be noted that the use of a coefficient 5 or 6 to find the approximate heat loss through a thick brick wall does not imply that an imaginary 1-in. thick wall would lose anything like 5 or 6 B.t.u. per hour per square foot per degree difference of temperature between the gases on one side and the air on the other. Such coefficients, strictly accurate only when applied to the internal temperature drop, give approximate results when used in connection with the over-all temperature drop, providing one is dealing with a thick wall and a material of considerable resistance.—Editor.]

Why the Consulting Engineer Should Design the Power Plant

The letter by T. A. Marsh in the Sept. 19 issue is timely and to the point. It is sometimes surprising to notice the indifference of owners of smaller plants as to employing consulting engineers, though sometimes the cost of the work that is to be done reaches a considerable sum.

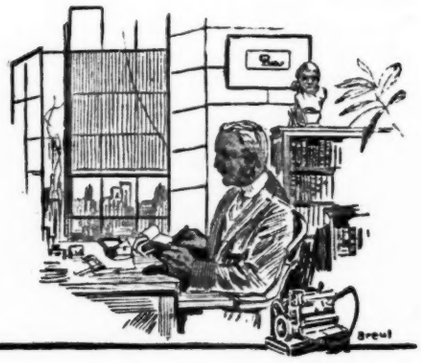
To remedy this condition, two things have to be accomplished. One is a constant driving home to the owners the fact that unless they employ competent engineers, they always run the risk of being imposed upon or losing out on the proposition by inferior equipment or faulty construction; the second which is even more important, is a more systematic and thorough organization of the engineering fraternity.

The stationary engineer may have all the knowledge and experience that is required to run a plant, but often he does not possess that broader education which is necessary in order to design and lay out a plant effectively and economically. Naturally, there should be a fraternal spirit between the designing and consulting engineer on one hand, and the stationary or plant engineer on the other hand, because by co-operation, they can produce results beneficial and advantageous to all concerned.

It is to be hoped that the time is not far distant when the work of the designing and consulting engineer will be more appreciated, and that they will receive a commensurate return for the years spent in serious study and for their constant efforts to make life more comfortable and insure greater ease and comfort and less physical exertion for the host of the great working masses. IGNACIO IZSAK.

Chicago, Ill.

QUESTIONS AND ANSWERS



Hunting of Governor

What causes a governor to hunt or race?—J. A. L.

Hunting is due to frictional resistance to motion of the governor weights in either direction, so the weights are tardy in responding to a change of the speed. During the period of delay the speed changes until the difference is great enough to overcome the frictional resistance. When the frictional resistance is finally overcome, the weights are likely to be moved too far, thus setting up a hunting action.

Velocity of Water in 3-in. Pipe

What would be the velocity of 100 gallons of water per minute discharged through a 3-in. standard iron pipe? P. D. C.

A standard 3-in. pipe, having an actual diameter of 3.07 in., would have a cross-sectional area of $3.07 \times 3.07 \times 0.7854 = 7.4$ sq.in. One hundred gallons would be $100 \times 231 = 23{,}100$ cu.in., and for 100 gal. per min. to flow through the pipe, the velocity would need to be $23{,}100 \div 7.4 = 3{,}121.6$ in. or $3{,}121.6 \div 12 = 260.1$ ft. per min., which would be equal to $260.1 \div 60 = 4.335$ ft. per sec.

Required Air Pressure Depends on Submergence

When raising water with air lift, must the air pressure be increased as the depth of the well increases if the submergence is kept the same at all depths?—E. L. W.

The air pressure required depends on the submergence. In starting up, more pressure will be required to establish column momentum, but after the flow is established the air pressure in the foot piece should be no greater than necessary to overcome the submergence, which, from pumping, usually becomes reduced by actual falling of the water level in the well.

Effective Pull of Belt

What is meant by the effective pull of a belt?—R. N.

In transmission of power by a belt and pulleys the effective pull is the difference of tension, or pull, of the tight and slack sides of the belt. The effective pull in transmission of a given number of horsepower, therefore, would be the same as the pull or tension of a single rope or cord being wound on the face of the driving pulley as it is unwound from the face of the driven pulley when transmitting the same power and moving at the same speed as the belt. The effective pull in either case would be the number of horsepower transmitted, multiplied by 33,000 and divided by the travel of the belt or rope in feet per minute.

Lowering of Generator Voltage

For many years an old-fashioned 125-volt 5-kw. shunt generator has been operating on a few incandescent lights. The voltage has been dropping of late, and now we cannot get good light at the usual speed. The commutation is good. Where should we look for the trouble? J. W.

It is a common occurrence for the field coils or armature winding to char the insulation gradually and produce short-circuits, causing a gradual drop in voltage. Try a voltmeter across the terminals of each spool, while at voltage. The voltages should be within 10 per cent of each other. If the difference is greater, look for short-circuits in the spool with the lower reading. Note if one or both coils are gradually getting hotter, which is also a sign of insulation breaking down. If the armature is greatly overheated and has a tendency to emit a smell or smoke, it should be rewound. It would be a good idea to overhaul the machine completely.

Relative Friction Loss Running Over or Under

Is more power derived from a given m.e.p. of an engine when running over than when running under?—J. H. C.

When running over, there is pressure from the crosshead on the lower guide, due to reaction of the connecting rod, weight of the crosshead and part of the weight of the piston rod and connecting rod. When running under, the reaction of the connecting rod is toward the upper guide, but is opposed by the weight of the crosshead and weights supported by the crosshead. Hence, in running under, the friction of the crosshead is less, and for the same lubrication and alignment the crosshead friction should be less and, other conditions being the same, a higher number of brake horsepower should be developed for the same m.e.p. However, the friction between the crosshead and guides usually amounts to a small percentage of engine friction, and the difference from running over or under could amount to only a small part of the work developed in the cylinder of the engine. The principal advantages of running over in place of running under are that with the pressure of the crosshead acting downward there is better opportunity of lubricating the guide that receives the principal wear, better opportunity of maintaining alignment and less tendency of pounding of the crosshead against the guides. With these superior operating conditions smoother running and less loss of power from engine friction usually are sustained when running over than when running under, and consequently, more useful power may be derived from a given m.e.p.

Heat Liberated from Conversion of Steam to Lower Pressure

What is the formula for the amount of heat liberated by conversion of a pound of dry saturated steam to steam at a lower pressure and given quality?—N. J.

The number of B.t.u. contained by a pound of water just prior to evaporation above the amount of heat contained at 32 deg. F. is called the heat of the liquid and usually is designated by the letter h.

The B.t.u. received in the process of evaporation is called the latent heat of evaporation and usually is designated by the letter L.

When evaporation is complete into the form of dry saturated steam, the total heat above 32 deg. F. or $h + L$, usually is designated by the letter H.

Calling H the B.t.u. of a pound of dry saturated steam at the higher pressure,

x the number of B.t.u. liberated by a pound of the steam when converted from the higher to the lower pressure,

h_2 the heat of the liquid at the lower pressure,

L_2 the latent heat of evaporation at the lower pressure,

q the quality or fraction of the steam at the lower pressure that contains the latent heat of evaporation for the lower pressure,

then for each pound of steam at the lower temperature the total heat would be $q \times L_2 + h_2$, and as the total heat contained per pound of steam when at the higher pressure was H, then x, the amount liberated in changing to the final condition, would be given by the expression,

$$x = H_1 - (q \times L_2 + h_2)$$

The values of H, L and h are to be obtained from steam tables, and the value of q must be obtained by a calorimeter test of the quality of the steam when condensed to the lower pressure.

Direction of Turning Engine Wheel for Locating Dead Centers

What is the proper method of turning the flywheel of an engine when finding the position of the flywheel for placing the crank on dead center?

Some textbooks state that for putting the engine on dead center, the engine always must be turned in the direction that it is to be run, in order to have the lost motion make itself felt in the same way as under running conditions. If this method is followed by applying a turning force to the flywheel, the crankpin is pulling the piston through the medium of the connecting rod, when under steam the piston would be pushing the connecting rod and pushing the piston, where under steam the piston would be pulling.

These conditions are illustrated in the accompanying diagrams, Figs. 1 and 2 showing positions of the crankpin when approaching and departing from the dead centers under running conditions. G. B. P.

Finding the position of the flywheel for which the crankpin is at dead center is not to be confused with putting or placing the engine on dead center to find the relative running position of the valve gear.

Instructions for valve setting usually describe (1) the method of finding dead-center position of the crank checked by the position of a point on the wheel with respect to a stationary point; and (2) the method of subsequently putting or placing the crank in the dead-center position so the valve gear will be in the same position in relation to the crank as when the engine is running.

When the same registration occurs of a mark on the guide with the crank above as when below the dead center, then by turning the wheel the crank will not stand the same distance above as below the dead-center positions of O unless both positions have been obtained by the crankpin pressing against the same brass of the connecting rod. To obtain equality of the distances for location of the dead-center position halfway between the tram marks in each instance for either dead center, the looseness of the crank and crosshead pins in their brasses must be taken up in the same direction as indicated by arrows A and B in the diagram. But in locating either dead center, it is immaterial whether both of the registrations of the crosshead with the guide are

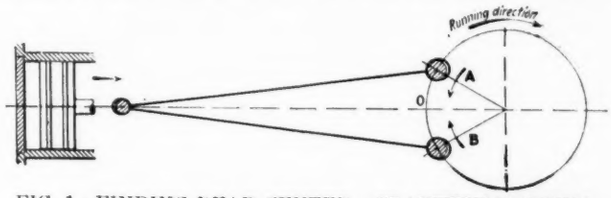


FIG. 1—FINDING DEAD CENTER. CRANKPIN PUSHING CONNECTING ROD

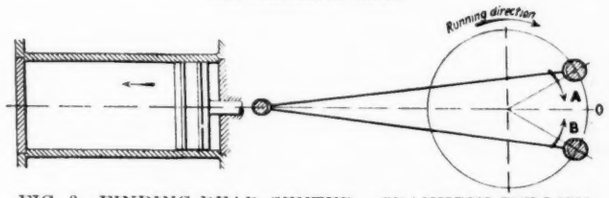


FIG. 2—FINDING DEAD CENTER. CRANKPIN PULLING CONNECTING ROD

made with the crankpin pulling the crosshead or both are made with the crankpin pushing.

By always turning the flywheel in the same direction when finding the position of dead center, by tramming, the wheel is placed in position for one of the trammings with the crankpin pushing, and the other position by pulling. Then a mark halfway between the tram marks could not be used to place the crank on true dead center, because the middle mark on the wheel would be too far around in the direction that the wheel was turned, due to looseness of the pins resulting in a change in distance of their centers going from a push on one side of the true center to a pull on the other. Hence, when the wheel is always turned in the direction the engine is to run, by taking a point halfway between the registering tram marks on the wheel the location of dead center would be made for a position assumed by the crank after the crankpin had passed beyond true dead center. But to bring the valve gear into running positions corresponding with different positions of the crank, the wheel always must be turned in the direction of running, in order to take up the lost motion of the valve-gear connections. However, if the position assumed for dead-center position of the crank is in error from always turning the engine forward while locating dead center, then, from erroneous assumption of a dead-center position, the operations of the valve gear referred to that position as correct would be later when referred to true dead center, because the assumed dead centers would occur earlier than the actual.

Steam-Turbine Operation*

By L. W. HELLER†

DURING the past year the production of power in the Duquesne Light Company system has been limited almost entirely to two major power stations, Brunot Island and Colfax, and so only eight of a total of thirteen turbo-generator units are in active service today. The minor and less efficient power stations, which contain the five idle units, are maintained as emergency stations.

The Brunot Island Power Station of the Duquesne Light Co. was built some twenty years ago as an engine plant, and the layout called for a total of ten cross-compound Corliss engines of 1,500 kw. each. However, only a few of the engines had been installed when it was decided to change to turbines, the first installation being a 3,000-kw. unit, which is still in the station but seldom operated. Following this 5,000-kw. turbine units were installed, to be replaced later with the 15,300-kw. units, which are still in operation.

As the station stands today, and is operating, there is a total of 119,500 kw. of turbo-generator capacity in the same space that would have held 10,500 kw. of engine capacity.

Floor Space and Operating Economy

The concentration of power allowed by the installation of turbine-driven generating units means more than the mere saving of land and building structure, for it allows the operation and production of greater blocks of power with a small number of operating attendants. The arrangement and installation of any turbine plant should receive consideration from the operating viewpoint, so that it can be operated with a minimum number of attendants. A plant with maximum kilowatts per square foot might be more involved and difficult to operate, requiring more men and a greater expense for maintenance.

While considerable thought is usually given to the economical generation of steam and to the thermal efficiencies of the prime mover, the expenditure for operating labor is often ignored. In the operation of a turbine room the size of that at Brunot Island, three attendants, in addition to the turbine operator or foreman in charge, take care of the operation, oiling, starting and records of turbine room

TABLE I—TURBINE AND AUXILIARY OPERATING ORGANIZATION FOR THREE EIGHT-HOUR SHIFTS

Title	No. Required per shift 1 Unit	2 Units	Duties
Turbine operator.....	1	1	In general charge of the operation of all turbine-room equipment, condenser equipment, station service and transformer rooms, boiler-feed pumps, forced-draft fans, intake screens and other auxiliaries. Reports to assistant chief engineer.
Asst. turbine operator...	1	1	In charge of operation of condenser equipment and basement auxiliaries. Reports to turbine operator.
Pump attendants.....	1	2	Each operates condenser auxiliaries connected with one unit.
Turbine attendants.....	2	3	Operate main units, house units, exciters, heat balance, motor-generator sets, forced-draft fans, boiler-feed pumps, compressors and evaporators.
Screen attendants.....	1	1	Operates revolving intake screens and assists in cleaning work.
	6	8	

in a satisfactory manner. The Brunot Island arrangement shows a capacity of 30,000 kw. per man, including the foreman.

On the basis of two-unit operation 30,000 kw. of turbine capacity will be operated per man.

The operating organization of the first unit has shown a production of 8,000 kw.-hr. per man-hour, and with the operation of two units a production of from 9,000 to 12,000 kw.-hr. per man-hour should be obtained, varying with the load factor of the station.

The tendency in the design of large power stations using turbo-generators as prime movers has been toward the use of higher pressure and temperatures than are generally desirable in the smaller isolated stations or under conditions where steam is conveyed long distances. The steam turbine is well adapted to the utilization of the higher pressures and superheats, and improvement in economy is being obtained by making use of these characteristics.

High-Pressure Units Must Be Close to Boiler

However, the use of high pressure and temperature steam makes it practically necessary to install the turbine in close proximity to the boiler plant, not only that the radiation loss be maintained at a minimum, but also in order that the number of steam-pipe joints with the resulting possibilities of leakage and losses between the boilers and turbines can be reduced. To date, the use of high pressures and temperatures has been generally confined to new stations which, because of their high economy, have been operated as base-load stations. Under such conditions the piping is not generally subjected to wide variations in load or to frequent shutdowns, as often occur to small stations, isolated plants or peak-load stations. Thus, the high-pressure stations do not have the steam piping subjected to the wide changes in temperature and the large condensation losses incidental to periods of extremely light-load or no-load operation.

A study of the latest power-station developments shows six large stations operating at steam pressures from 275 to 300 lb. per sq.in. and eight at pressures between 300 and 350 lb. per sq.in. Nine of these stations are operating at steam temperatures between 650 deg. and 700 deg. F.

Turbine operation and maintenance are very much more satisfactory in such installations where corrosive and erosive action within the turbine can be prevented and the blading, strainer and valve stems kept free from accumulation of foreign material which results from priming boilers or entrainment of corrosive gases.

The use of higher steam temperatures will have a tendency to reduce erosion due to moisture, by transferring the location of the saturated steam to a lower-pressure stage of the turbine.

The rebuilding of corroded or eroded turbines is an expensive job, so that the tendency today is toward the use of a standardized feed water which will not carry corrosive constituents or result in priming and the carrying of suspended solids over into the turbines and condensers.

The use of surface condensers and maintenance of tight steam and water piping will allow the makeup to be reduced to a point where the use of evaporators for furnishing makeup is the proper installation. A makeup of 1.75 per cent is entirely possible.

At Colfax, with an evaporator makeup plant, an excellent condition of the tube surface on the steam side is maintained. The B.t.u. per square foot per hour heat transfer averages very close to the design figures.

Instruments Showing Mechanical Condition

Thermometers and pressure gages at the individual bearings often will indicate means to prevent bearing trouble. Permanent installation of thermometers to show the variation in the temperatures of the oil discharged from the bearing, give an operating indication that will keep the operator on safe ground in the operation of the lubricating system. For some time now we have made it standard practice to equip all bearings as well as oil coolers with the proper complement of thermometers.

The proper installation of steam-pressure gages connected to the various stages of the unit will be found very desir-

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†General Superintendent Power Stations, Duquesne Light Co., Pittsburgh, Pa.

able in checking up the internal condition of the unit. In the reaction type of turbine failure of a row or even several rows of blades can and has occurred without sufficient disturbance to call it to the attention of the operator, and the simplest way such a condition can be determined is by comparing the stage pressures existing at the time with a standard pressure for the load that the unit is carrying when the observation is taken.

The proper complement of instruments should be installed with the unit so that it will be an easy matter to check the performance. In the case of surface condensers provision should be made for determining the amount of air leakage,

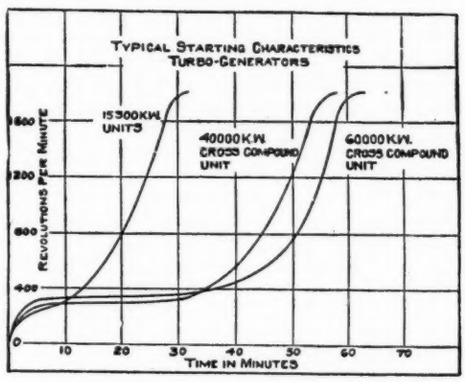


FIG. 1—STARTING REACTION UNITS

as an excessive air leakage will affect the performance of the condenser materially, owing to overloading of the air-removal pumps, as well as decreasing the heat transfer through the tubes. Where dry vacuum pumps are used for air removal, an air bell is the most satisfactory means of air measurement, and on the basis of past experience we have set 3 cu.ft. of free air per minute as the permissible air leakage per 25,000 sq.ft. of condensing surface.

In cases where the steam-jet or hydraulic type of air pump is installed, an orifice installation on the air vent, if properly calibrated, will give very good results for guiding the operating organization.

Instruments Showing Thermal Efficiency

The mercury manometers are not used for securing data, but merely give a rough indication of vacuum when the unit is being started. The need for correction for barometric pressure complicates operating records so much that the use of temperature as an indication of exhaust pressure or vacuum was found to be much more satisfactory. The use of two-pen recording thermometers recording exhaust temperature as well as temperature of circulating-water discharge gives a continuous record of the performance of the condenser.

The lubricating or oiling system of a turbo-generator unit is very important from an operating viewpoint and should receive the proper attention not only in the operation, but also in the installation of equipment. Provisions should be made to keep a continuous supply of lubricating oil, but also maintain it of a proper quality.

Many different kinds of oil have been used in turbines and very likely always will be, but the usual turbine oil is a special grade. The oil in use has a specific gravity of 0.867 at 15/15 deg. C. Saybolt viscosity of 150 at 100 deg. F. The demulsibility of the oil when new will probably run in excess of 1,200 c.c./hr. and, as it ages with use, will decrease to about 100 c.c./hr.

Table II shows analyses of turbine oils taken from a number of different installations, representing a number of different refiners as well as operating conditions.

Some operators have reported considerable difficulty, due to sludging of oil, with a consequent fouling of the oiling system. Others report as their major trouble the emulsion of the oil, due to the leakage of water into the system.

Several cases are known to the writer where oil in a turbo-generator unit has been in service for years without filtering, only a small amount being added for replacement of the loss, but the practice today is toward the installation of a complete oil storage and filtration system in connection with the installation of turbo-generators.

The selection of turbine operators or engineers is a very important one and should receive due consideration. Often, men who have had considerable steam-engine experience are placed in charge of turbines and find that the work is entirely different and that they may even have false ideas that will be a decided disadvantage in the operation of turbo-generators. In the selection of a man to take charge of the operation of large units, we prefer one who has had a varied experience, serving perhaps as electrician, repairman or boiler operator, and is thus pretty well acquainted with all classes of equipment. He should be a young man who can be trained to think fast and act accordingly. Our selection of men for the responsible positions of turbine operators based on requirements similar to the foregoing has been a satisfactory one.

TABLE II—COMPARATIVE OIL UALITIES

Unit	Saybolt Viscosity At 100 Deg. F.	Specific Gravity	Acidity Expressed Mg KOH/GM	Demulsibility c.c./hr.	Remarks
A	150	0.875	0.02	1,200	New oil
			0.05	115	Six weeks' service
B	190		0.36	120	Six weeks' service
C	157	0.871	0.51	104	Not filtered service
D			0.56		Five months' service
E			0.74		Ten months' service
F	158	0.873	0.34	103	Indefinite service
G	148	0.868	0.02	1,590	New oil
H	156	0.868	0.24	141	Seven weeks' service
I	147	0.870	0.20	115	Thirteen weeks' service

However, after the personnel for the operation of the turbines has been selected, a systematic method of instruction and development should be worked out, depending a great deal on the individual qualifications of the operator.

Starting Up Turbine Units

The normal starting time for a 15,300-kw. unit is 30 minutes, although it is possible to start them and have them synchronized in 15 minutes, but for regular operation where no emergency exists, the longer period is best. The larger units, such as the 40,000 and 60,000 units, are started and brought up to speed in a period of from 55 to 70 minutes. Of this period, during the first 45 minutes the turbine is rotated at low speed (300 to 600 r.p.m.), and after it is thoroughly equalized in temperature, it is brought up to speed rapidly, as shown in Fig. 1.

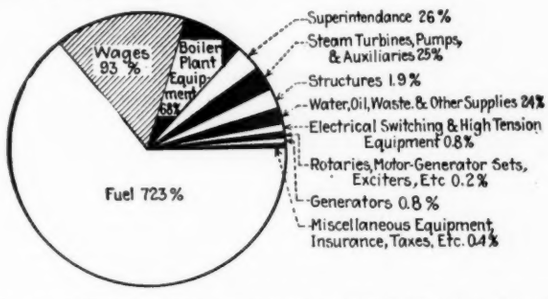

Wages 9.3 %
Boiler Plant Equipment 6.3%
Fuel 72.3 %
Superintendance 2.6 %
Steam Turbines, Pumps, & Auxiliaries 2.5%
Structures 1.9 %
Water, Oil, Waste, & Other Supplies 2.1%
Electrical Switching & High Tension Equipment 0.8%
Rotaries, Motor-Generator Sets, Exciters, Etc 0.2%
Generators 0.8 %
Miscellaneous Equipment, Insurance, Taxes, Etc. 0.4%

FIG. 2—DISTRIBUTION OF OPERATING EXPENDITURES OF A LARGE CENTRAL STATION

Fig. 2 shows a typical distribution, in more detail, of the maintenance and operating costs of a turbo-generator station. Data from one large power station over a period of years showed a turbo-generator maintenance cost of 45 cents per kilowatt of capacity per year. Of this cost approximately 55 per cent was chargeable to turbines and 45 per cent to generators.

The maintenance of steam turbines is important, not so much on account of economy or cost, but in order that the unit can be kept available for service when needed. Such a requirement demands co-ordination of the maintenance of the units in the different power stations at such times as load conditions permit, through a complete and detailed schedule of their inspection and maintenance program.

Because of the small number of wearing parts in a steam turbine the majority of the cases of trouble of an operating

nature will probably come from bad adjustment of some particular detail. Owing to this characteristic the maintenance program will be primarily one of inspection and adjustment.

The maintenance of a turbo-generator can be divided into two classes: First, the maintenance that is carried on from day to day and week to week, which does not require the withdrawal of the unit from service for any appreciable time; secondly the periodic inspection and overhauling which necessitates the complete dismantling of the unit, with consequent withdrawal from service for a considerable period.

Such maintenance requires constant diligence on the part of the operating organization and inspectors, so that the slightest defect will be observed and remedied before it causes trouble. It also requires an organization that is conversant with the maintenance of large steam turbines and thus able to do necessary replacement of parts most efficiently.

In order that no delays may occur, a proper supply of spare parts for the equipment should be maintained. Installation of duplicate units, or even units of similar type, will greatly reduce the number of parts that must be carried in stock.

It is the policy of the Duquesne Light Co. to schedule the complete overhauling of a unit approximately each twelve months. At such times the unit is completely dismantled, all details are checked up and such parts as may indicate weakness or wear repaired or replaced.

In addition to complete overhauling, a constant check on the operating condition is maintained and summarized; thus a system of routine reports, cleaning and routine maintenance and adjustment, is scheduled at frequent intervals, so that the lubricating system, governor mechanism and steam valves receive proper attention.

The oil coolers and oiling system should be kept clean and tight. The use of condensate as a cooling medium removed the serious problem of keeping the water side of coolers clean in many cases, and in connection with large units, reclaims an appreciable amount of heat. Thorough cleaning of the oiling system, by wiping or through the circulation of hot water, assists in the removal of a great deal of the deposit that may accumulate.

The governors, relays and connected mechanism form a very important function in the operation of the unit, and failure to function when called upon may result disastrously. Such mechanisms should be given routine and special tests from time to time in order to check their performance.

The governing mechanism is merely the guiding hand in the closing or opening of important steam valves connected to the unit. Most large units have both the governor and the throttle valves so controlled that they should close when the unit overspeeds. However, having two valves in series should not lessen the responsibility that is placed on either valve, and their performance should be checked regularly.

In order to insure that the foregoing detail is properly checked, a written report is required on the functioning of the trip mechanism and valves each time a unit is shut down, overspeeds or is in any other way placed under unusual conditions.

In cases where the unit in question operates continuously under load for weeks at a time, such as the 60,000 unit at Colfax, a test is made on one throttle valve at a time while the load is carried by another line and valve installed for testing purposes.

Coal Commission Act a Compromise Between House and Senate Bills

After pressure had been exerted from high administrative quarters to break an apparent deadlock among the conferees, the bill to create the United States Coal Commission was finally enacted into law as a compromise between the original House and Senate bills.

In its final form the legislation provides for a commission of seven members, instead of the five proposed by the Senate bill and the maximum of nine provided by the House bill. Restrictions as to the personnel of the Commission were removed in conference, except that no member of the House or Senate may serve. The House bill had provided that no person identified with the coal-mining industry might be appointed and the Senate bill had excluded executive officers of the government. An appropriation of $200,000 is provided, this sum being halfway between the $300,000 of the House bill and $100,000 of the Senate bill.

The point which nearly wrecked the conference, that of inclusion in the Senate bill of instructions to the Commission to report on "the advisability or wisdom of nationalizing the coal industry" and "the feasibility or necessity of governmental regulation and control of the coal industry," was compromised by rewriting these two subsections into one, reading "the advisability of any legislation having to do with government or private ownership, regulation or control in the coal industry."

This rewriting of the two sections into milder form represents a considerable concession on the part of Senator Borah, author of the Senate bill, which was compensated to a large degree, however, by acceptance by the House conferees of the terms of the Senate bill instructing an inquiry and report on various forms of standardization of wages, production, etc.

The act provides that the first report of the Commission shall be presented to the President and to Congress not later than Jan. 15, 1923. It provides for a separate investigation of the anthracite industry, with a separate report on this field to be submitted on or before July 1. The life of the act is limited to one year. The salary of the Commissioners is fixed at $7,500 annually and no employee of the Commission is to be paid a salary in excess of this sum.

Additional legislation affecting the coal industry was proposed in the closing days of the session of Congress. Representative Volstead proposed a joint resolution for the submission of a constitutional amendment which would give the federal government control over coal, oil and gas. Representative McSwain, of South Carolina, introduced a bill seeking to protect shipments on contracts. No committee action on either measures will be taken until Congress reconvenes.

Would Save Coal by Developing Hudson River Power

That further hydro-electric development of the upper Hudson River would save 2,000,000 tons of coal annually is asserted in a report issued by the New York State Water Power Commission. Data given in the report show that of 368,000 hp. available on the upper Hudson and its tributary, the Scandaga River, only a little over one-third is now developed.

Leaving out of consideration the Niagara and St. Lawrence Rivers, the Hudson is the most important stream in the state from the viewpoint of water power. To develop the present unused power of the Hudson, estimated at 222,000 hp., the State Water Power Commission recommends in its report the construction of fourteen storage reservoirs, with a total capacity of 70 billion cubic feet. Such a system of reservoirs would cost about $25,000,000, but the commission asserts that the storage value would many times exceed the first cost, and that the reservoirs would mitigate greatly the damage due to floods, as well as increase the available water power of the Hudson, Scandaga and Schroon Rivers.

The work of preparing the report, directed by Frank M. Williams, state engineer and a member of the Water Power Commission, was a continuance of investigations previously conducted by the conservation commission of the state's power resources.

Twenty-three major applications for preliminary permits and licenses for the development of water power have been received by the Water Power Commission during its first year of activity, functioning under the so-called Robinson water-power law. However, the Commission's chief accomplishment to date has been the holding of hearings. Very little has been done in the way of actual building construction and the development of power, since it has only been

during the last two years that anything like a definite water-power policy on the part of the state has been attempted.

The Commission is now negotiating with the Secretary of State at Washington and with the Canadian government with the idea of increasing the amount of water (at present limited by international treaty) which may be diverted out of the Niagara watershed for power purposes. This is essential for the success of both the American and the Dominion projects now under way. The completion of the Queenston-Chippawa power development project will entail the diversion of water slightly in excess of the treaty limitations for the Canadian side; in the interval the application of the American Superpower Corporation for a similar development at a similar cost on the American side, was informally returned pending negotiations for an increase in the amount of water that may be diverted.

The Water Power Commission finds itself unable to act on applications for the development of power involving in part the use of state lands in the forest preserve, such as the application of the Moose River Power Co. An amendment to the constitution of the State of New York has passed one session of the legislature and is due for passage again next year, when the people will have a chance to decide if a percentage of state-owned lands in the forest preserve may be utilized under the supervision of the Commission for power development.

Applications have been received for the use of approximately one-third of the surplus canal waters of the state. Some of the surplus is already being used, and the State of New York itself, in its hydro-electric plant now under construction at Crescent Dam on the Mohawk River, will use a large percentage of these waters. No hearings have been held on the applications involving canal waters, since the superintendent of public works is required to certify before a license is issued that such waters are not necessary for the navigation and operation of the canal, and in no case has such a certificate of approval been issued.

A.S.M.E. Members Hold Regional Meeting and Form New Section

Under the auspices of the Engineering Society of Western Massachusetts members of the American Society of Mechanical Engineers in that locality, together with representatives from other New England sections, held a three-day regional meeting at the Hotel Kimball, Springfield, Mass., Sept. 25-27. The technical sessions dealt with subjects of local industrial interest and were supplemented by automobile excursions to a number of manufacturing plants, paper mills and power companies.

Monday morning was devoted to the subject of power, in which R. A. Packard presented a paper on "Multiple Source of Power from Reliable Industrial Plant Operation."[1] The speaker described the power system at the Ludlow Manufacturing Associates, where a power group consisting of steam and hydro-electric plants, supplemented by high-tension breakdown service supplies several mill groups. The location of these plants and their interconnection have insured uninterrupted operation in the mills.

In an extemporaneous talk R. J. S. Pigott compared the advantages of central-station service with those of the private plant. He alluded to the large number of industrial plants that have simply grown to their present size by additions from time to time without any definite plan or with little regard to economical layout. He believed that stokers should be used even in the relatively small plant, inasmuch as the more efficient type of fireman is rapidly disappearing.

Exhaust Steam for Processes

In his opinion many processes now using live steam could get along well on exhaust. In support of this he cited an experience in a large industrial plant where he had changed over from high pressure to exhaust steam for cooking kettles. The head of that department had protested that he was unable to secure results with the exhaust steam, and Mr. Pigott had changed back to satisfy him, but on the following Sunday had again made the exhaust-steam connections and changed the pointer on the gage to make it appear that high-pressure steam was being used. No further complaints were received. He had also found from experience that, in general, steam hammers can be operated better on air than on steam, and that in spite of the losses in compressing the air, the general economy is better.

The discussion that followed was centered around the reliability and economy of the central station as compared with that of the private plant, and a division of opinion was apparent. This led finally to a consideration of metering the steam. One speaker said that in the shops of the General Electric Co. at Schenectady there are about 160 steam-flow meters and a careful monthly balance is maintained of the steam produced and that credited to the various departments. The difference, or unaccounted-for steam, serves to indicate the extent of losses, and if this is excessive an investigation is immediately made, traps inspected, etc. It was generally conceded that engineers are now making greater use of their meter readings than formerly.

Monday afternoon two papers were presented—one on "Application of Engineering Principles to the Selection of Paper," by Dr. R. E. Rindfusz, and the second, "Steam Utilization in a Modern Newsprint Mill," by S. W. Slater and J. E. A. Warner.[2] The latter paper favored the employment of a private plant on account of the use for exhaust steam in drying. The authors emphasized the desirability of selecting the prime mover with such a water rate as would give the desired quantity of dry saturated exhaust. An engine or turbine of too high economy would not produce enough heat in the exhaust, hence much of the exhaust steam would be too wet. On the other hand, a prime mover of too high a water rate would likely produce superheat in the exhaust and this is undesirable in the dryers.

Paper and Rubber Plants Visited

Monday afternoon one group of the members was taken by automobile to the plant of the Strathmore Paper Co. at Woronoco, where they were shown the process of making paper. Dinner was held at the Strathmore Inn, and in the evening Col. B. A. Franklin, vice-president of the Strathmore Paper Co., gave a talk on "Management in the Paper Industry." This was followed by motion pictures on paper manufacture.

A second group of the members was taken on an inspection trip through the plant of the Fisk Rubber Co. at Chicopee Falls, after which dinner was served at the company's plant and the party listened to an address on "Rubber and Automobile Tire Manufacture," by William Jameson, of the Fisk Rubber Company.

Tuesday's papers were as follows: "Preservation of Decaying Wood Roofs" by Wendell S. Brown, "Standardization of Machine Tools" by F. H. Colvin and K. H. Condit, "Standardization of Small Tools" by C. J. Oxford. Following this session a luncheon was tendered the council of the American Society of Mechanical Engineers at the Kimball and in the afternoon there were excursions to the manufacturing plants of Holyoke. The parties met in the evening at Mt. Tom Summit House where a dinner was served and the final session held at which a Western Massachusetts Section of the American Society of Mechanical Engineers was formed with Chas. L. Newcomb as chairman. Among the speakers at the dinner were president-elect John L. Harrington, past-president Fred Miller, Chas. L. Newcomb and H. Bowman, who acted as toastmaster. Mr. Harrington referred to the growing importance of the engineer in civic as well as industrial affairs and gave a word of advice to the new section as to how it might co-operate with other local bodies. Mr. Miller emphasized that industrial harmony and efficiency can be brought about only by brains. "Management," he said, "must always realize that it is dealing with human beings and to this end every successful industrial establishment must be an educational institution."

On Wednesday automobile excursions were made to the plants of the Hartford Electric Light Co. and to the hydro-electric plant of the Turners Falls Power and Electric Company at Greenfield.

[1] This paper will be abstracted more fully in a later issue.

[2] This paper was abstracted in the Sept. 19 issue.

News in the Field of Power

To Reopen Muscle Shoals Campaign in December

Just before the adjournment of Congress advocates of the Henry Ford offer for Muscle Shoals got together and laid tentative plans for the active renewal of their efforts when the two houses reconvene in December. Two bills will be pressed at that time—the McKenzie bill, providing for acceptance of the Ford bid with the Gorgas steam plant excluded, and the Wright bill, which calls for acceptance of the Ford offer with Gorgas included.

In order to learn the prospects of having these bills set on the calendar for early consideration, conferences were held with Majority Leader Mondell and others prominent on the Republican side of the House.

Leader Mondell is quoted as having assured the Ford advocates that personally he saw no objection to having the Ford offer brought on the floor of the House early in the next session, although he pointed out that there is much other important legislation which has been pending for a longer period. An aggressive fight on the part of the Ford advocates is anticipated when Congress again meets, unless the measures are given early consideration.

Hearings also will be asked immediately by Representative Hull on his recent resolution, outlined in *Power* for Sept. 26, to give the Secretary of War the power to dispose of the whole Muscle Shoals question.

An Engineer for the Post-Office Department

In order that a mechanical engineer may pass upon the labor-saving devices now used for the more expeditious handling of the mails, and upon those constantly being proposed, Sidney W. Farnsworth, of Evanston, Ill., former aide to Commander McDowell, and a member of the staff of Admiral Sims during the war, has been appointed by Postmaster-General Work as chief engineer of the Post Office Department.

Mr. Farnsworth comes to Washington from the Steel and Tube Co. of America, Evanston, Ill., and was at one time connected with the Westinghouse company. During the war his duties involved an acquaintance with all the newest military developments in use in the land, sea and air forces. At another time he was scientific attache to the American Embassy in London.

In his new position Mr. Farnsworth will have general supervision over mechanical equipment and labor-saving devices in all branches of the postal service. He will examine new devices and determine whether they should be adopted by the department. Heretofore this work has been done by committees appointed by the Postmaster-General from the various bureaus of the department and composed of men who had no special training for such work.

Although the postal business has doubled in the last ten years, there has been an increase of but 9 per cent in personnel, resulting in an imperative need for machinery to expedite the handling of mails, and for the employment of someone competent to select and care for such machinery.

The New Fuel Distributor Goes to Work

The appointment of Conrad E. Spens as Federal Fuel Distributor, under the new coal distribution act, was made by the President on the recommendation of Secretary of Commerce Hoover. Mr. Spens was chief of the traffic division of the Food Administration throughout its existence, and Secretary Hoover, therefore, had ample opportunity while serving as food administrator to become familiar with the appointee's ability. Mr. Spens is regarded as one of the outstanding traffic men of the country. He has been given leave of absence by the Chicago, Burlington & Quincy Railroad Company, of which he is vice-president.

One of the first acts of the new distributor was to telegraph the state governors, reminding them that the principal control over prices must be exercised by the state authorities—that federal control can be applied only to coal that moves interstate. He again emphasized the conclusion reached at the bituminous coal conference last week, that coal production capacity at present exceeds transportation capacity.

"It appears necessary," said Mr. Spens, "that state organizations or agencies be created that will invite cooperation, that will prevent stocking of coal beyond current necessity, and that will establish reasonable margins for retailers and wholesalers."

The new fuel distributor will have as his chief assistants Donald Conn, a specialist in the Lake trade and the requirements of the Northwest, and F. R. Wadleigh, chief of the coal commodity division of the Department of Commerce.

Other members of the distributor's staff are C. P. White, of St. Paul, Minn.; C. J. Hepburn, of Philadelphia, who has been retained as general counsel to the distributor; E. M. Durham, of the American Railway Association, who will represent Mr. Spens at the Philadelphia sessions of the committee of anthracite operators and Pennsylvania state officials who are considering the anthracite distribution problem; and H. M. Griggs, of the Cleveland Ore and Coal Exchange, who will continue handling the movement of Lake coal.

Italian Engineer Honored at A.I.M.E. Luncheon

Italy, defying Bryon's prophecy of sorrow and fatal beauty, was pictured as a rising industrial power at a luncheon given by the Iron and Steel Committee of the A.I.M.E. in New York City on Sept. 26, in honor of Dr. Federico Giolitti of Turin, a leading metallurgist and the head of the great Ansaldo works at Genoa. Dr. Giolitti has just made a tour of America, and the luncheon was tendered him on the occasion of his departure.

In an appeal for co-ordination between the iron and steel industries of the United States and Italy, Dr. Giolitti said that he thought that the two countries could work together in this field. Italy, he said, has an abundance of labor, which America lacks, while America, on the other hand, has an abundance of fuel and raw materials, greatly needed in Italy. He expressed confidence that a pooling of effort in both countries would help to solve the problems of cost and distribution. By other speakers at the luncheon, Dr. Giolitti was eulogized as a powerful force in the internationalization of industrial effort in all civilized countries.

Power Permits and Licenses in the Far West

The American River Power and Water Co. has filed application for a comprehensive irrigation and power project in Placer and Eldorado counties, California. The project includes the construction of a diversion dam in the Rubicon River, a large reservoir at French Meadow, in the middle fork of the American River, and four power houses on the north fork and main stream. The stored water, after passing through the last power house, will be used to irrigate lands below Auburn in Placer and Sacramento counties. The company estimates that 188,000 hp. will be developed.

A license has been granted the Utah Power and Light Co., Salt Lake City, for its Soda site on Bear River, a few miles above the existing Grace plant. The preliminary permit for this and three other sites on the river was granted in 1921. The market for power in Utah has grown so rapidly during the last two years that further generating capacity is now greatly needed. Two hydro-electric units of 10,500 hp. capacity each will be installed in the new plant, which will be connected by a 132,000-volt transmission line with the existing system.

In the Sept. 5 issue, on page 396, it was erroneously reported that the powdered-coal system at Henry Ford's new plant at Ford City was to be of Ford manufacture.

France To Hold Fuel Exposition and Congress

An international exhibition of liquid fuels, organized by the Société de Chimie Industrielle, will be held in Paris from Oct. 4 to 15, under the patronage of the Ministers of Commerce, Agriculture, Colonies, Public Works and Aëronautics.

The exposition will be divided into two groups, production and utilization, and the fuels exhibited will consist of petroleum, schists, lignite and peat, tar and benzol, alcohol, and vegetable oils. In connection with the exhibition an international congress of fuels will be held from Oct. 9 to 15.

Big Engineering Merger

The International Combustion Engineering Co. has taken over the entire capital stock of the Green Engineering Co., East Chicago, manufacturers of chain grate stokers, economizers and auxiliary boiler-room equipment, it was announced on Sept. 28. Stockholders of the Green company have taken in exchange 47,000 shares of International stock.

By this merger, the International Combustion Engineering Co. acquires a plant covering twelve acres and valued at close to a million dollars. The Green company had about $500,000 cash on hand at the time of the merger, with accounts payable of less than $50,000.

Says Federal Power Commission May Act in New York State

A motion to dismiss the petition filed by the State of New York in the United States Supreme Court, seeking to restrain the Federal Power Commission from issuing preliminary permits and licenses within the state, has been filed by Solicitor-General James M. Beck.

The New York petition seeks to test the constitutionality of the water-power act. The supporting brief filed by State Attorney-General Newton last May sets forth the claim that the Federal Power Commission is exercising authority which rightfully is reserved to the state; that it assumes jurisdiction over all streams other than brooklets, and that it is depriving the state of revenue. The license granted the Niagara Falls Power Co. and the preliminary permit granted the Lower Niagara River Power Co. accompany the petition as exhibits of the authority exercised by the Commission.

In the petition to dismiss, Solicitor-General Beck declares that the petition does not join essential parties as defendants; that it does not present any concrete question; that it does not present a controversy within the original jurisdiction of the Supreme Court; that it does not set forth any cause of action against the defendants—who are Secretaries Weeks, Fall and Wallace and Attorney-General Daugherty; that the bill of complaint is without equity and that no concrete loss is established.

The government's motion sets forth the claim that if New York State has suffered any loss or injury because of the license issued the Niagara Falls Power Co. or the preliminary permit granted the Lower Niagara River Power Co., these corporations should have been made defendants to the petition.

Solicitor-General Beck also recites various court decisions in support of his contention that the water-power act is constitutional and that the Federal Power Commission is proceeding in a lawfully regulated manner.

Society Affairs

Metropolitan Section, A.S.M.E., will hold a fall get-together at 7 p.m. on Oct. 11 at the Machinery Club, Hudson Terminal Bldg., 50 Church St., New York City.

Pennsylvania Association No. 18, N.A.S.E., Pittsburgh, Pa., has issued the program for a series of special educational meetings to be held during the coming winter. On Oct. 5 Carl D. Bushnell, sales engineer, will give a paper on vacuum cleaning, and on Oct. 19 Harbour Mitchell, vice-president of the American Foundry and Construction Co., will talk on piping.

Coming Conventions

Society of Industrial Engineers, 29 West 39th St., New York City. National convention, New York City, Oct. 18-20.

Society of Naval Architects and Marine Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

American Society of Mechanical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 7-13.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 7-13.

Business Items

The Quigley Furnace Specialties Co., New York City, has announced the addition to its sales and service department of M. F. King, formerly of the King Refractories Co.

The Brown Instrument Co. has opened a New England branch at 185 Devonshire St., Boston, in charge of George Goodman, and a Southern branch at 619 Brown-Marx Bldg., Birmingham, Ala., in charge of Charles L. Saunders.

Wm. W. Nugent & Co., Inc., has established as representative for the British Empire, except Canada, J. Golder & Co., Moorgate Hall, Finsbury Pavement, London, E.C.; and as European representative on the Continent, Alfred Du Bois, Ing., 51 Boulevard Garibaldi, Paris, (15).

The Diamond Power Specialty Corp., Detroit, Mich., has appointed Lynn W. Nones as Eastern manager of the marine department, with offices at 90 West St., New York City. Mr. Nones was formerly manager of the marine department of the Griscom-Russell Co., and previous to this connection was associated with the Worthington Pump & Machinery Corp.

The Power Specialty Co., 111 Broadway, New York City, has appointed Pell W. Foster, Jr., as New England district manager, with offices at 50 Congress St., Boston.

The Roach Stoker Co., Philadelphia, has appointed the Dingle-Clark Co., Engineers' Building, Cleveland, Ohio, as its distributor in the Ohio, northern Kentucky and southern Indiana territory.

The Howard Iron Works has been favored by a decision of the United States District Court for the Western district of New York, sustaining its "Howard Guided Expansion Joint," made under the Bogart re-issued patent No. 14906 of July 6, 1920.

Trade Catalogs

Telescopic Hoist—Gillis & Geoghegan, 537-39 West Broadway, New York City. Illustrated pamphlet No. 190 describing the "G & G" electric and hand-operated hoists for raising ash cans from basement to street in hotels, schools, libraries, etc.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Sept. 18, 1922	Sept. 25, 1922
Pool 1,	New York	$5.00–5.75	$5.50–6.00
Smokeless,	Columbus	5.50–6.00	5.75–6.25
Clearfield,	Boston	4.00–4.75	4.00–5.00
Somerset,	Boston	4.50–5.25	4.25–5.25
Kanawha,	Columbus	5.25–5.75	5.50–6.00
Hocking,	Columbus	4.75–5.50	4.50–5.00
Pittsburgh No. 8	Cleveland	4.50–4.75	4.50–4.75
Franklin, Ill.,	Chicago	4.50–5.00	4.50–5.00
Central, Ill.,	Chicago	4.35–4.75	4.35–4.75
Ind. 4th Vein,	Chicago	4.65–5.00	4.65–5.00
West Ky.,	Louisville	4.00–4.50	4.00–4.50
Big Seam,	Birmingham	2.60	2.60–3.00
S. E. Ky.,	Louisville	5.25–6.00	5.00–6.25

FUEL OIL

New York—Sept. 28, Port Arthur light oil, 22@25 deg. Baumé, 5c. per gal.; 30@35 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

Chicago—Sept. 23, for 24@26 deg. Baumé, $1.20 per bbl.; 32@36 deg., 3½c. per gal. in tank cars, f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—Sept. 12, f.o.b. refinery, Pennsylvania, 36@40 deg., 6½c.; Kentucky fuel oil, 26@30 deg., 4½c. per gal.; Gas oil, 32@34 deg., 2¾c. per gal.; 36@38 deg., 3c.; 38@40 deg., 3½c.; Western, 24@30 deg., $1.30 per bbl.

Philadelphia—Sept. 25, 26@28 deg. Baumé, Oklahoma, $1.20@$1.25 per bbl.; 30@34 deg., Oklahoma (group 3), 3½@3⅝c. per gal.; 16@20 deg. Seaboard, $1.50@$1.60 per bbl.

Cincinnati—Aug. 21, for 26@28 deg. Baumé, 5½c.; Diesel, 28@30 deg. 5½c. per gal.; distillate 38@40 deg., 6c.

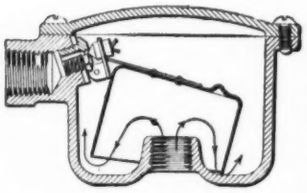
Cleveland — Aug. 21, 26@28 deg. Baumé, 4½c. per gal.

Condensed-Clipping Index of Equipment

Condensed from previous descriptions in "Power" for convenient filing

Trap, Steam "Power," 1922.

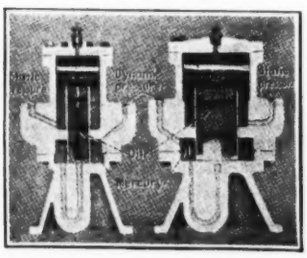
Armstrong Machine Works, Three Rivers, Mich.



This steam trap uses an inverted bell float instead of the more usual closed type of float. Water enters at the bottom and follows the direction of the arrows, passing out at the top. The weight of the float holds it down and keeps the valve open. When steam or air comes in, however, it rises straight up into the inside of the bell float, finally giving the latter enough buoyancy to raise it and close the valve, thus keeping the steam from blowing through the trap. Air escapes through the small vent in the top of the float, but any steam that passes through this hole is condensed by the surrounding water. When the steam inside the float condenses, the water level rises, the float drops and the valve opens. The model shown here is 3½ in. high and is designed for pressures up to 150 lb., with a capacity for from 435 to 2,496 lin.ft. of 1-in. pipe. A larger model takes pressures up to 200 lb. Described further in "Power" for April 4, 1922, page 534.

Flow-Meter, Electrical "Power," 1922.

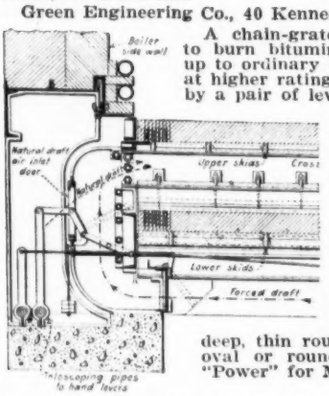
Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.



A redesigned electrical flow-meter, based on the same principles as those in the previous Republic meter, but having 91 instead of 41 electrical contact points, thus covering the same range as before in more than twice as many steps. This arrangement correspondingly reduces the possible error between the indicated flow and the actual flow. The new model is at the right, and the old at the left. Both depend for their operation upon the rise and fall of mercury, controlled through the usual Pitot tube. As the mercury rises in the central chamber it makes contact with one after another of the 91 rods, thus cutting out successively the resistances to which they are connected. These resistances are in circuit with an indicating device that is calibrated to show the flow of steam or other fluid in the pipe. Described further in "Power" for Feb. 14, 1922, page 257.

Grate, Forced Draft "Power," 1922.

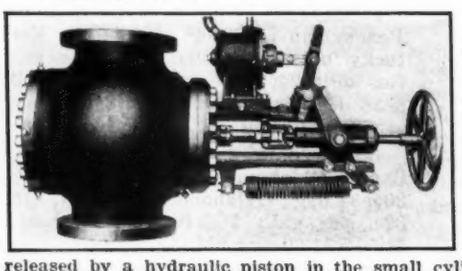
Green Engineering Co., 40 Kennedy St., East Chicago, Ill.



A chain-grate stoker designed particularly to burn bituminous coal under natural draft up to ordinary ratings and under forced draft at higher ratings. The dampers are controlled by a pair of levers for each of the five stoker compartments. Forced draft comes up from below through a central air duct, passing up around the sides and into the five compartments in the space between the upper and lower leads of the chain. Natural draft comes through passageways on both sides of the grate outside of the forced draft chambers. Both dampers are shown closed, although normally one or the other is open. The chain is of heavy design, and is made up of deep, thin round-hole links, strung on either oval or round bars. Described further in "Power" for May 30, 1922, page 859.

Valve, Emergency Closing "Power," 1922.

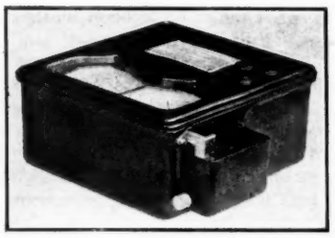
Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa.



An automatically closing valve designed to be placed in the individual steam-supply pipe of a large turbine, right next to the header. It is closed by the combined action of the steam flow and a large coil spring after a catch has been released by a hydraulic piston in the small cylinder at the top. This piston is operated by a drop in pressure in one end of the cylinder, which is brought about, through relief piping, in case of a break in the steam line serving the turbine, overspeeding of the turbine, or failure of the lubricating oil supply. Described further in "Power" for May 23, 1922, page 815.

Meter, Concentration "Power," 1922.

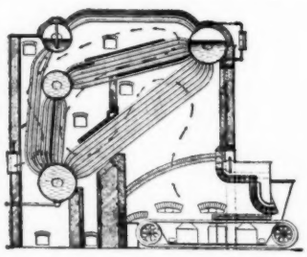
Esterline-Angus Co., Indianapolis, Ind.



A portable, quick-reading, electrically-operated meter designed to make it simple and convenient to test boiler water for its degree of concentration. The principle of operation of the device is that the electrical resistance of water decreases as the concentration increases. A sample of the water to be tested is placed in the small cup at the side of the instrument, in which there are two exposed electrical contacts. Electricity is thus made to pass through the water between these points and also through an ordinary ohm-meter movement that is calibrated directly in degrees of concentration. The meter is operated by alternating current. The ohm-meter element is of the induction type, mounted on a ball bearing without pivots or jewels. Described further in "Power" for March 28, page 499.

Boiler, Water-Tube "Power," 1922.

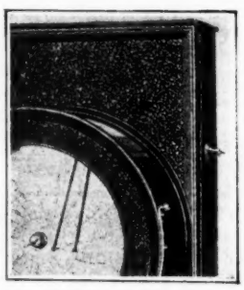
Lasker Iron Works, Chicago, Ill.



A new design of bent-tube boiler, designed by R. J. Adams, of the Lasker Iron Works, with the object of obtaining the maximum surface in the first bank by using the longest tubes possible, set at the greatest inclination the head room will allow. The designer's calculations indicate that the hot gases from the fire would not pass directly over the bridge wall, but would swing up through the first bank of tubes near the top, as indicated by arrows. The steam outlet and the feed water inlet are both in the top rear drum. The cold water passes down through the three rear rows of tubes, which are in the path of the cooler gases and so act as an integral economizer. The baffling may be arranged for four passes and bottom take-off for the gases, as shown in the illustration, or for three passes, with top take-off. Described further in "Power" for Feb. 28, 1922, page 342.

Meter, Combined CO_2 and Steam "Power," 1922.

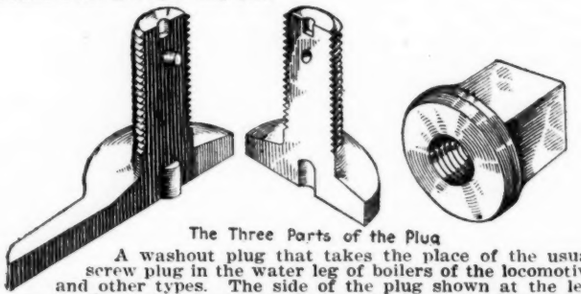
Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.



A combination of the Republic Co.'s standard CO_2 recorder with its standard steam-flow meter, so as to show the two records on the same chart. It was felt that the most accurate guides in economical boiler operation are steam flow and CO_2, since the one shows the performance of the boiler in generating steam, and the other shows the performance of the furnace in burning the fuel. It is suggested also that when the operator is forcing the boiler to meet a heavy demand for steam, with this device, he cannot help but see the CO_2 record at the same time that he watches the steam flow, and so is more likely to pay some attention to economy in the way of proper firing conditions. The combination of the two instruments was accomplished by mounting the electrical recording part of the flow-meter on the door of the CO_2 recorder. Described further in "Power" for Feb. 21, 1922, page 308.

Plug, Washout "Power," 1922.

Frank Crist & Co., Lima, Ohio



The Three Parts of the Plug

A washout plug that takes the place of the usual screw plug in the water leg of boilers of the locomotive and other types. The side of the plug shown at the left in the illustration is put into the hole in the boiler first, drawn over to one side and the other half inserted; the two halves are then drawn together and the nut is screwed on. The extension on one of the halves prevents the plug from being turned around. Described further in "Power" for June 20, 1922, page 966.

For a permanent file of new and improved power-plant equipment, clip and paste on 3 x 5-in. cards. (Patented Aug. 20, 1918.)

New Plant Construction

PROPOSED WORK

Ala., Birmingham—The Alabama Power Co., B. M. Bldg., plans the construction of a 90 mi. 110,000 volt transmission line from Lafayette to Openka, also a 44,000 volt line in the industrial district, here. Estimated cost $1,000,000. Engineer not announced.

Ark., Russsellville—The Arkansas Light & Power Co., Arkadelphia, plans to build a hydro-electric plant on the Illinois River, here. Estimated cost $100,000. Quotations wanted on turbines, generators and auxiliary machinery.

Calif., San Francisco—The city and county of San Francisco are having plans prepared for the construction of a 3 story school, gymnasium, library, etc., on Van Ness Ave., near Hayes St. Estimated cost $800,000. J. Reid, Jr., City Archt., 1st National Bank Bldg.

Calif., San Francisco — C. Grillo, c/o Standard Investment Co., 948 Market St., is having plans prepared for three 6 story apartment buildings on Eddy, Hyde and O'Farrell Sts. Wm. Beasley, 948 Market St., Archt.

Conn., West Hartford—The town, B. I. Miller, Mgr., will soon award the contract for a 2 story, 200 x 210 ft. high school, including steam heating system, on South Main St. Estimated cost $450,000. W. T. Marchant, 36 Pearl St., Hartford, Archt. Noted May 10, 1921.

D. C., Wash.—A. L. Flint, Gen. Purch. Officer of the Panama Canal, will receive bids until Oct. 13 for 1 oil handling pump, 1 electric motor 10 hp. 750 r.p.m. complete with compensator, 1 ammeter, 1 voltmeter portable for 25 cycle a.c., 500 insulators, 200 condulets, 350 switches, 125 transformers, 13,500 ft. conduit, etc.

Fla., Apalachicola—W. G. Eager, Engr., Dalton Bldg., Valdosta, Ga., will receive bids until Oct. 5 for equipment for municipal electric light plant to include 2 Unaflow engines with generators, one 4 panel switchboard, steam and water piping and fittings, electric motors, transformers and line material, etc.

Fla., Orlando—The Orlando Utilities Co. plans to build a 75 x 175 ft. electric generating plant, to be operated in conjunction with a waterworks plant. Estimated cost $300,000. Prices wanted on turbo-generator boilers, electric pumps, etc.

Fla., Pensacola—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans the construction of a steam distribution system, here. Estimated cost $25,000.

Ill., Chicago—A. S. Alschuler, Archt., 28 East Jackson St., is preparing plans for a 3 story, 105 x 125 ft. office building, including steam heating system, on Congress and Laflin Sts. Estimated cost $250,000. Owner's name withheld.

Ill., Chicago—Woltersdorf & Bernhard, Archts., 138 North La Salle St., plans to build a 13 story, 118 x 125 ft. office building, including steam heating system, on Madison and Hamlin Sts. Estimated cost $1,250,000. Owner's name withheld.

Ill., Oak Park—B. Ruglen, c/o B. P. Steif, Archt., 64 West Randolph St., Chicago, is having plans prepared for a 3 story, 125 x 143 ft. apartment hotel, including steam heating system, on Washington Blvd. Estimated cost $250,000.

Ind., Crawfordsville—The city plans to build a 1 story 28 ft. extension to light and power plant and 200 ft. radial stack, also install one 3000 kw. turbine, service condenser and auxiliary, 750 hp. water tube boiler, mechanical stoker, 5000 hp. heater. Estimated cost $200,000. H. C. Carroll, Terminal Bldg., Indianapolis, Engr.

Ind., Mishawaka — The city is having plans prepared for a 1,500,000 gal. reservoir, pumping equipment, extensions and other improvements. Burns & McDonnell, Interstate Bldg., Kansas City, Mo., Engrs.

Ind., Richmond—The Consumers' Service Co. plans to build a 1 story refinery, with 5 tanks of 100,000 gal. capacity. Estimated cost $200,000. Architect not selected.

Ind., South Bend—The Oliver Hotel Co., Main and Washington Sts., is receiving bids for a 7 story, 65 x 125 ft. hotel addition. Estimated cost $600,000. H. H. Green, 30 North Michigan Ave., Chicago, Archts. Noted Jan. 24.

Ia., Des Moines—The Bd. Educ., G. Garton, Secy., has had plans prepared for 2 junior high schools, including steam heating systems, on East 25th and University and 31st and Center Sts. Estimated cost $275,000 each. Proudfoot, Bird & Rawson, 810 Hubbell Bldg., Archts.

Ia., Des Moines—B. J. Kavanagh, Fleming Bldg., is having plans prepared for a 4 story apartment building, including steam heating system, on Grand and West 10th Sts. Estimated cost $250,000. Vorse, Kraetsch & Kraetsch, 911 S & L Bldg., Archts.

Ia., Sioux City—The New Samaritan Hospital Assn., E. J. Stason, Pres., Bd. Trustees, plans to build a 3 or 4 story hospital, including a steam heating system, on 29th and Douglas Sts. Estimated cost $250,000.

Ia., Waterloo—The Arcade Hotel Co., c/o G. C. Janney, is having plans prepared for a 4 story, 110 x 150 ft. hotel, including steam heating system. Estimated cost $300,000. Architect not announced.

La., Ashton — T. A. Labauve plans to build a small rice mill, also a grits and meal mill. Want catalog and prices on crude oil engines.

Mass., Pittsfield—The city plans to build a 3 story high school on East and Second Sts. Estimated cost $500,000. Architect not selected.

Mich., Dearborn—The Ford Motor Co., Highland Park, plans to build a 1 story, 200 x 800 ft. experimental laboratory, including steam heating and power equipment. Estimated cost $250,000. A. Kahn, 1000 Marquette Bldg., Detroit, Engr.

Mich., Detroit — Donaldson & Meier, Archts., 1314 Penobscot Bldg., will receive bids until Oct. 10 for 6 seminary buildings, including 2 story, 64 x 147 ft. power plant for heating purposes, with stack, 3 boilers, with feed pumps, incinerator, coal bunkers, mechanical coal conveyors, stokers, ash handling equipment, etc., for the Sacred Heart Seminary, 1219 Washington Blvd.

Mich., Holland—The Bd. Educ. is having revised plans prepared for a 3 story, 110 x 160 ft. high school with 30 study rooms, manual training and music rooms, laboratories, and printing and machine shops, on River Ave. Estimated cost $260,000. Robinson-Campau, 715 Michigan Trust Bldg., Grand Rapids, Archts. B. Parks & Son, Grand Rapids, Engrs.

Mich., Northville—Detroit Municipal Tuberculosis Sanatorium, 1415 St. Antoine St., Detroit, will receive bids until Oct. 9 for furnishing and installing material and equipment for coal hopper, bins, elevator and conveying system, for Sanatorium, here. Stratton & Snyder, Union Trust Bldg., Archts.

Minn., St. Paul—The Dept. Educ., L. R. S. Ferguson, Comr., City Hall, will soon award the contract for a 3 story, 100 x 250 ft. junior high school, including steam heating system, on Isabel and Congress Sts. Estimated cost $300,000. F. X. Tewes, City Hall, Archt. Noted Aug. 15.

N. H., Bristol—The Utilities Power Co., Meredith, plans the construction of a hydro-electric power plant and a 1,200 ft. dam, 55 ft. high, on the Pemigewasset River, Ayers Island. Estimated cost $1,000,000. Engineer not announced.

N. Y., Brooklyn—The Bd. Educ., 500 Park Ave., New York, received bids for heating and ventilating temperature regulating apparatus for P. S. 102 from E. Rutzler Co., 404 East 49th St., $41,914, D. J. Rice, 42nd and Lexington Ave., $41,487, J. C. Williams, 233 Bway., $41,755; P. S. 67 from Raisler Heating Co., 129 Amsterdam Ave., $71,345, D. J. Rice, $71,167, T. F. Hall, 405 Lexington Ave., $71,083. Contractors all of New York. Noted Sept. 19.

N. Y., Brooklyn—The Jewish Hospital, E. C. Blum, Pres., Prospect Pl., will receive bids until Oct. 5 for a 5 story, 70 x 105 ft. hospital addition. Ballinger Co., 47 West 34th St., New York, Archts. and Engrs.

N. Y., Brooklyn—The New York Telephone Co., 15 Dey St., New York, is having plans prepared for Telephone Exchange on 3rd Ave., here. Estimated cost $425,000. McKenzie, Voorhees & Gmelin, 342 Madison Ave., New York, Archts. and Engrs.

N. Y., Creedmoor (Jamaica P. O.)—The State Hospital Comn., Rm. 1046, 25 Bway., New York, will receive bids until Oct. 31, for the construction, heating, sanitary and electric work, for central heating and lighting plant, kitchen and dining room building and buildings for chronic patients (North and South) and construction of tunnels at the Creedmoor Division, Brooklyn State Hospital, here. Noted Sept. 26.

N. Y., Elmira—The Wolcott Motor Co., 122 State St., is in the market for one 400 or 500 ft. boiler, horizontal type.

N. Y., New York—The Bd. Educ., 500 Park Ave., is having plans prepared for addition to P. S. 121 on East 102nd St. and 2nd Ave. Estimated cost $500,000. C. B. J. Snyder, Concord St. and Flatbush Ave., Bklyn., Archt. and Engr.

N. Y., Niagara Falls—Niagara Falls Memorial Hospital, 640 11th Ave., plans to build an addition and make improvements. Estimated cost $250,000. Architect not announced.

N. Y., Patchogue—The Bd. Educ. will receive bids until Oct. 16 for a high school. Estimated cost $500,000. Tooker & Marsh, 101 Park Ave., New York, Archts. and Engrs. Noted Sept. 19.

N. Y., Sheepshead Bay—The Superior Ice Co., Inc., 50 East 42nd St., New York, is having plans prepared for an ice plant on Avenue Z and East 17th St. Estimated cost $250,000. W. Mortensen, 209 West 76th St., New York. Archt. and Engr.

N. C., Winston-Salem—The city plans to build a market building on 6th and Cherry Sts. Estimated cost $300,000.

Ohio, Cincinnati — The Vernon Manor Co., 16 East 7th St., have had sketches prepared for a 7 story, 140 x 208 ft. apartment building, on Burnet and Oak Aves. Estimated cost $1,500,000. Gorber & Woodward, 2803 Union Central Ins. Bldg., Archts. and Engrs.

Ohio, Cleveland—The Bd. Educ., F. G. Hogan, Dir., received bids for a 3 story, 300 x 311 ft. high school on East 152nd St. and St. Clair Ave., from The Drummond-Miller Co., 4500 Euclid Ave., $1,689,900, Craig-Curtiss Co., Cook Bldg., $1,719,987, A. Doll, Euclid Heights Blvd., Cleveland Heights, $1,806,000, steam heating system, Feldman Bros., 10,305 Barrett Ave., $234,800. Noted Aug. 29.

Ohio, Massillon—The Bd. Educ., E. P. McConnaughy, Pres., is having plans prepared for a 2 story school, including steam heating system, on North St. Estimated cost $250,000. C. W. Bates, 604 Marshall Bldg., Cleveland, O., Archt.

Ore., Grants Pass—Grants Pass Irrigation District, Bd. of Directors received bids for 2 units of centrifugal pumps, one 9000 g.p.m., 154 head, 450 hp. motor and one 4500 g.p.m., 141 head, 200 hp. motor, directly connected, automatic compensator control, from DeLaval Steam Turbine Co., L. C. Smith Bldg., Seattle, Wash., $7,570, Lea Courtenay Co., East Ferry and Main Sts., Newark, N. J., $7,509, Power Equipment Co., 806 Lewis Bldg., Portland, $7,650. Noted July 25.

Pa., Altoona—Penn Central Light & Power Co., 1809 Union Ave., plans a $165,000 bond issue for extensions and improvements to lines and plant.

Pa., Bridgeport—The Bd. Educ. is receiving bids for the construction of a 2½ story, 69 x 164 ft. high school, including steam heating system. H. C. Richards, 608 Chestnut St., Phila., Archt.

Pa., Greenville—Greenville Steel & Iron Co., H. E. McConnell, Vice Pres. and Genl. Mgr., is having plans prepared for the construction of a steel plant, to consist of 150 x 500 ft. rolling mill, 100 x 150 ft. open hearth building, 60 x 450 ft. boiler house, a 50 x 150 ft. machine shop and a 50 x 100 ft. warehouse, all 1 story. Estimated cost $3,500,000. Private plans.

Pa., McKees Rocks — The Cheesebrough Mfg. Co., 17 State St., New York, will soon award the contract for manufacturing plant, here, consisting of 7 buildings, including power house, boiler house, warehouse and manufacturing buildings. Estimated cost $1,000,000. Hunting Davis Co., Century Bldg., Pittsburgh, Archts. Noted May 30.

Pa., Phila.—Ballinger & Co., Archts., 12th and Chestnut Sts., is receiving bids for a 6 story, 100 x 329 ft. metal working factory on 21st St. and Hunting Park Ave. for the Budd Mfg. Co.

Pa., Phila.—A. H. Brockie, Archt., 254 South 15th St., is receiving bids for a 6 story, 39 x 138 ft. addition bank and office building, at 1510 Chestnut St., for the Corn Exchange Bank. Estimated cost $1,500,000. Noted Aug. 8.

Pa., Phila.—The General Electric Co., River Rd., Schenectady, N. Y., is receiving bids for a 7 story, 140 x 175 ft. addition to switch factory, on 7th and Willow Sts., here. Private plans.

Pa., Phila.—The Insurance Co., of North America, 232 Walnut St., will soon receive bids for a 20 story office building on 16th and Arch Sts. Estimated cost $1,500,000. Stewardson & Page, 315 South 15th St., Archts. Stone & Webster, Real Estate Trust Bldg., Engrs. Noted Mar. 14.

Pa., Pitcairn—Pennsylvania R.R., Central Region, Broad St. Station, Phila., will soon award the contract for the construction of a 62 x 107 ft. storage and airbrake shop, 40 x 200 ft. rivet cutting building, 103 x 424 ft. paint shop and bake oven, 100 x 760 ft. freight car repair shop, 14 x 26 ft. oil house, 43 x 203 ft. store hause and welfare building and a 16 x 31 ft. oxygen and acetylene storage building. Estimated cost $500,000. A. C. Shand, Broad St. Station, Phila., Engr.

Pa., Williamsport—The city plans to vote $1,000,000 bonds for the construction of sewers, additions to permanent lighting system, also pavements and streets. Engineer not announced.

Pa., York—The Gilbert Wall Paper Co., 728 Linden Ave., is in the market for machinery and equipment for power house, in connection with new plant.

R. I., East Providence—Atlantic Refining Co., 715 Hospital Trust Bldg., Providence, plans to build a large receiving and distributing oil plant, including about 20 large storage tanks, pump houses, garages, etc., at Kettle Point off Barrington Parkway, here. Private plans.

R. I., Pawtucket—J. & P. Coats, Inc., 366 Pine St., will soon award the contract for two 2 and 3 story, 95 x 370 ft. and 95 x 270 ft. mill buildings, additions to their present plant, including steam heating. Estimated cost $375,000. Private plans.

Tenn., Memphis—The Office of the District Engr., U. S. Army, will install boilers for hydraulic grader, estimated cost $10,000; also machinery for grader, $12,000.

Tex., Brownfield—The city plans improvements to electric light and power plant, $16,000 bonds have been approved.

Tex., El Paso—H. B. Stevens, Mills Bldg., plans to install an electric plant, including equipment to supply power for elevators and electric lights, in the Mills Building. Estimated cost $27,500.

Tex., Temple—Dr. J. M. Woodson, 204 West Downs Ave., will receive bids until Oct. 11 for mechanical and electrical work, for a 3 story, 74 x 101 ft. hospital, including forced hot air ventilating and heating system. Wm. W. Scott & Co., 412½ Franklin St., Waco, Engrs.

Wis., Delavan—The State Bd. of Control, M. J. Tappens, Secy., is receiving bids for refrigerating machinery and cooling apparatus for the State School for Deaf. A. Peabody, Capitol Bldg., Madison, Engr. Noted Aug. 15.

W. Va., Morgantown—The University of West Virginia, c/o State Bd. of Control, Charleston, have plans prepared for a 4 story, 40 x 79 ft. and 79 x 254 ft. chemistry building, here. Estimated cost $400,000. Davies & Dunlap, 1713 Sansom St., Phila., Pa., Archts.

Wis., Green Bay—Foeller & Schoeber, Archts., Nicolett Bldg., are receiving bids for a 2 story, 100 x 105 ft. dairy and power and boiler house, for the Fairmont Creamery Co., 200 North Bway. Estimated cost $60,000.

Wis., Milwaukee—The Dept. Pub. Wks., R. E. Stoelting, Comr., will receive bids until Oct. 19 for furnishing and installing, three 400 hp. horizontal water tube boilers, with furnaces, settings, stokers, superheaters and forced draft apparatus in the Riverside Pumping Station, at the foot of Chambers St. G. Staal, City Hall, Engr.

Wis., Milwaukee—The Grand & Sixth Bldg. Co., c/o O. Brochman, 420 East Water St., is having plans prepared for a 7 story, 150 x 205 ft. theater and office building on 6th and Grand Sts. Estimated cost $2,000,000. M. Tullgren & Sons Co., 425 East Water St., Archts. C. W. and G. L. Rapp, 190 North State St., Chicago, Ill., Assoc. Archts.

Wis., Wauwatosa — Milwaukee County, c/o Bd. Trustees, W. L. Coffey, Secy., county institutions are having plans prepared for a central electric lighting plant on Watertown Rd. Estimated cost $80,000. F. A. Vaughn, Inc., 290 3rd St., Milwaukee, Engr.

B. C., Vancouver—Seaman Paper Mills, 208 South La Salle St., Chicago, Ill., are negotiating for site and water rights for proposed plant here. If the deal goes through they will use power from the Bridge River Power Co., and the Bridge River Power Co. will build new power plant. Estimated cost $3,000,000. V. D. Simons, 39 South La Salle St., Chicago, Ill., Engr.

Ont., Galt — The Bd. Educ. will soon award the contract for a 3 story school, including steam heating system and mechanical ventilation. Estimated cost $300,000. Cameron & Ralston, Bartlett Bldg., Windsor, Archts. H. H. Angus, Continental Life Bldg., Toronto, Engr.

Ont., Hanover—The city council plans election Oct. 16 to vote $135,000 for reservoir and pumping station, tower, additional mains and 3½ mi. 4 in. pipe line. J. Taylor, City Hall, Engr. Prices wanted on all materials and equipment.

Que., Montreal—The Red Star Sales Co., Canada Cement Bldg., plans to build refinery, 1,000 bbls. capacity. Estimated cost $250,000. Red Star Refiners Co., Ltd., Canada Cement Bldg., Engrs.

CONTRACTS AWARDED

Calif., Grenada—The Grenada Irrigation Dist., awarded contracts for rebuilding pumping plants to L. Youdall, Commercial Bank & Savings Bldg., Stockton, $5,255, structures for 24 mi. of canals, to D. M. Reid, $7,369, new canals and deepening present canals, to G. Milne, Fort Jones, $18,671. Bids for reconstructing dam rejected, work will be done by day labor. Noted Sept. 26.

Calif., Oakland—The Bd. Educ awarded the contract for heating and ventilating systems for proposed Theodore Roosevelt high school, to W. H. Picard, 5656 College Ave., $73,900. Bids for general contract rejected, new bids will be taken. Noted Aug. 15.

Col., Denver—Gov. O. H. Shoup, State House, and others, awarded the contract for an 8 story, 75 x 200 ft. hotel and four 45 x 175 ft. wings, on Speer Blvd. and Ellsworth and Bayand Aves., to the Fleisher Constr. Co., 606 Builders' Exchange, Minneapolis, Minn. Estimated cost $5,000,000.

Ill., Chicago—F. J. Campbell, 68th and Merrill Sts., awarded the contract for a 3 story, 120 x 125 ft. apartment building, on 68th and Clyde Sts., to D. O. Crilly, c/o owner. Estimated cost $450,000. Steam heating system will be installed. Noted Sept. 19.

Ill., Chicago—The Ravenswood Hospital Assoc., c/o Frank D. Chase, Inc., Archts., 645 North Michigan St., awarded the contract for a 4 story, 100 x 150 ft. hospital on Wilson Ave., to H. B. Barnard, 140 South Dearborn St. Estimated cost $300,000. Steam heating system will be installed.

Ia., Des Moines—The Commodore Holding Co., 101 Commercial Security Bldg., awarded the contract for a 5 story, 65 x 120 x 170 ft. apartment hotel, to the Fleisher Constr. Co., 101 Commercial Security Bldg., about $500,000. Steam heating system will be installed.

Kan., Atchison—E. Brielmaier & Sons Co., Archts., 432 Bway., Milwaukee, awarded the contract for a 4 story academy building for the Mt. Scholastica Academy, 8th and Eccher Sts., here, to the Immel Constr. Co., 200 North Main St., Fond du Lac. Estimated cost $650,000. Noted Aug. 15.

Mass., Boston—The Chamber of Commerce, 177 Milk St., awarded the contract for a 12 story, 113 x 184 ft. office building, on Federal and Franklin Sts., to the Evatt Constr. Co., 161 Devonshire St. Estimated cost $3,000,000. Steam heating and modern ventilating systems will be installed. Noted Aug. 29.

Mass., Boston—Edison Electric Illuminating Co., 70 State St., awarded the contract for an 8 story office building at 33-39 Boylston St., to G. B. H. Macomber Co., 44 Bromfield St. Estimated cost $350,000. Steam heating system will be installed.

Mass., Indian Orchard—Indian Orchard Co., manufacturer of cotton goods, awarded the contract for the construction of a 1 story, 40 x 60 ft. boiler house to the Casper Ranger Constr. Co., 20 Bond St., Holyoke. Estimated cost $75,000.

Mass., Somerville — The Bd. Educ. awarded the contract for a 3 story junior high school on Winter Hill, to F. G. Coburn, 294 Washington St., Boston. Estimated cost $800,000. Steam heating and ventilating systems will be installed. Noted Aug. 8.

Me., Waterville — The Sisters Hospital, College Ave., awarded the contract for a 4 story addition to hospital, to D. H. Walker, 529 Dutton St., Lowell, Mass. Estimated cost $500,000. Steam heating system will be installed. Noted July 11.

Mich., Hamtramck—Dodge Bros., 7900 Jos. Campau Ave., Detroit, will build an 8 story, 200 x 400 ft. addition to automobile factory, for assembling and finishing bodies. Work to be done by construction department. Estimated cost $1,500,000. Noted Sept. 19.

Minn., East Grand Forks—The city, A. N. Briggs, Clk., awarded the contract for 1 raw water and 1 clear water motor-driven centrifugal pumps, to R. B. Whitacre & Co., 205 South Robert St., St. Paul, $5,290. Noted Sept. 12.

Minn., Willmar—The city, H. Gunderson, Clk., awarded the contract for an underground electric distribution system for light and power service and ornamental lights, including removal of overhead wires, to the Power Equipment Co., 212 3rd Ave. N., Minneapolis, about $60,000.

Mont., Glendive—The Northern Pacific Ry. Co., 5th and Jackson Sts., St. Paul, Minn., awarded the contract for a 45 x 94½ x 30 ft. power house and engine room and a 2 story, 50 x 153 ft. store house, here, to the Winston-Grant Co., 902 Exchange Bank Bldg., St. Paul, Minn.

N. Y., Brooklyn—The Rubel Coal & Ice Corp., Glenmore Ave., will build an ice plant on Atlantic Ave. by separate contracts under supervision of architect. Estimated cost $500,000. E. M. Adelsohn, 1778 Pitkin Ave., Archts. and Engrs.

N. Y., New York—The Dept. Parks, Municipal Bldg., awarded the contracts for a southeast wing and court building for the American Museum of Natural History, 81st and Central Park West, as follows: general, J. Stewart & Co., 30 Church St., $1,069,000; steam heating and fume removal apparatus, etc., Federal Heating Co., 300 Madison Ave., $66,431; ventilating and humidifying apparatus, Baker Smith Co., Inc., 576 Greenwich St., $19,600. Noted Sept. 19.

N. Y., New York—Harby, Abronst & Melius, 15 East 40th St., will build by separate contracts, an 11 story, 100 x 110 ft. office building at 27 West 60th St. Estimated cost $500,000.

N. Y., New York — The 915 West End Ave. Corp., c/o R. Candella, Archt., and Engr., 200 West 72nd St., will build by day labor, a 15 story apartment building at 911 West End Ave. Estimated cost $850,000.

N. D., North Fargo (Fargo P. O.)—The village, H. L. Faust, Clk., awarded the contract for waterworks system, including pump house, pump, 100,000 gal. elevated tank on 100 ft. tower, 4,255 ft. 8 to 12 in. c.i. pipe, hydrants, valves, etc., to Schruth & Jackson, 633 Plymouth Bldg., Minneapoils, $34,383.

Ohio, Cleveland—The Cleveland Electric Illuminating Co., Ill. Bldg., Pub. Sq., awarded the contract for a 3 story, 35 x 168 ft. switch house and 337 ft. tunnel, 7 ft. 7 in. dia., on East 70th St., to the Sam W. Emerson Co., 1836 Euclid Ave. Estimated cost $200,000.

Pa., Phila.—The Traylor Engr. Co., Broad St. and Lehigh Ave., awarded the contract for an 8 story, 124 x 205 ft. automobile factory to Wm. Steel & Sons, 16th and Arch Sts., $455,000.

R. I., Woonsocket—Sacred Heart College, awarded the contract for a 2 and 3 story college building on Bernon Heights, to Bouvier-Brien Constr. Co., 189 Sayles St. Estimated cost $500,000. Steam heating system will be installed.

S. D., Colome—The city awarded the contract for waterworks system, including well, pump house and machinery and about 11,000 ft. 6 in. c.i. pipe, to the Ellerman-McLain Co., Yankton, about $27,000.

W. Va., Coalwood — The Consolidation Coal Co., Watson Bldg., Fairmont, awarded the contract for a 35 x 50 ft. boiler house, stack, settings and steam engines, to the Rust Engr. Co., 1901 5th Ave., Pittsburgh, Pa. Estimated cost $90,000.

Ont., Port Credit—The council awarded the contract for pumping equipment for new pumping station, to the Turbine Equipment Co., 73 King St. W., Toronto, hydrants to the Dominion Steel Products Co., Brantford. Estimated cost $45,000. Noted Aug. 15.